SAND2015-1337R

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Photos placed in horizontal position with even amount of white space between photos and header

# Data on MOS Hall Bars 1410-1413 for distribution to UW-Madison

Dan Ward

9/22/2014

U.S. DEPARTMENT OF ENERGY

National Nuclear Security Administration

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# 1410-1413

TMLu

05/20/2014

U.S. DEPARTMENT OF ENERGY

National Nuclear Security Administration

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# Purpose of this set

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- This set (1410 – 1413) are Al/reactive/AlO/Si Hall bars built on no-poly Si wafers using the same process flow as for SiGe devices.
- The purpose is to see whether the process flow has any problem without complications from possible material issues of SiGe.

# Summary of results

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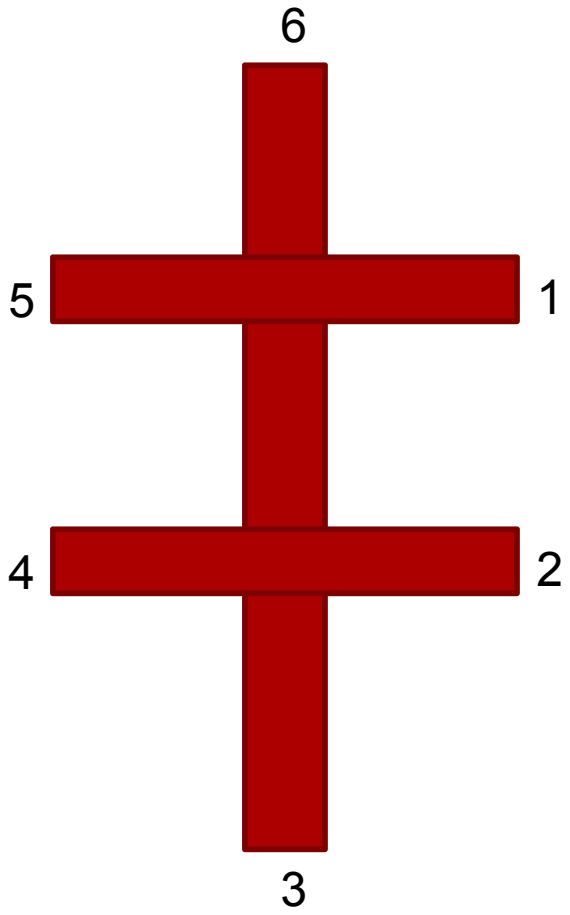
- Two quadrants of each sample were measured at 4K.
- Device behavior:
  - Conductance is modulated by gate. Good!
  - No leakage current within -2V to 2V. Good!
  - No hysteresis. Good!
  - Threshold voltages are negative. Why?
- The results suggest that the process flow, including the mask, oxide removal, UVO3/HF clean, Al/AlO deposition, works as it was intended to.
- Minor problems:
  - negative threshold.
  - Sample 1412-1413: parasitic current path not suppressed by AG.

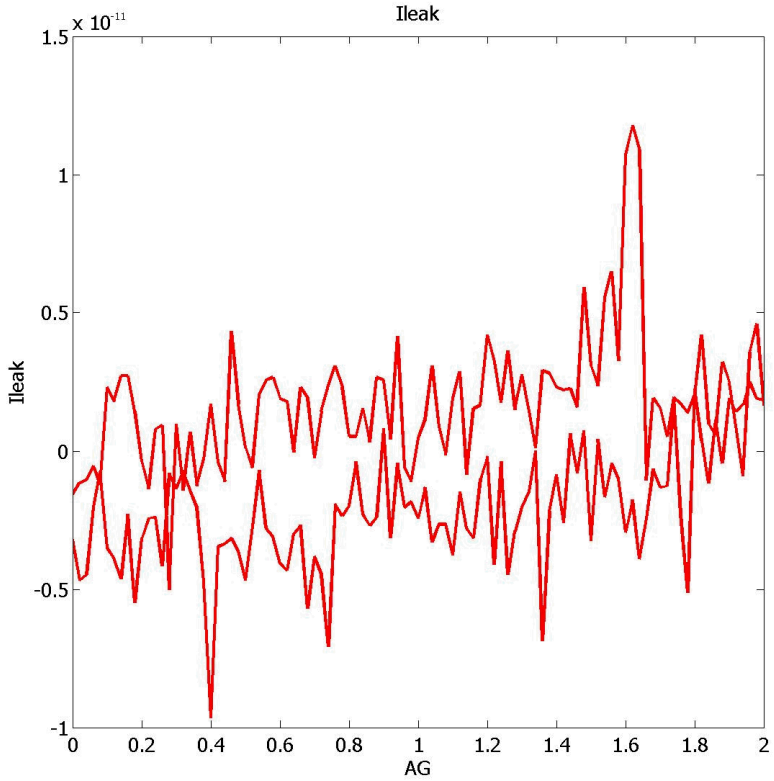
# Measurements

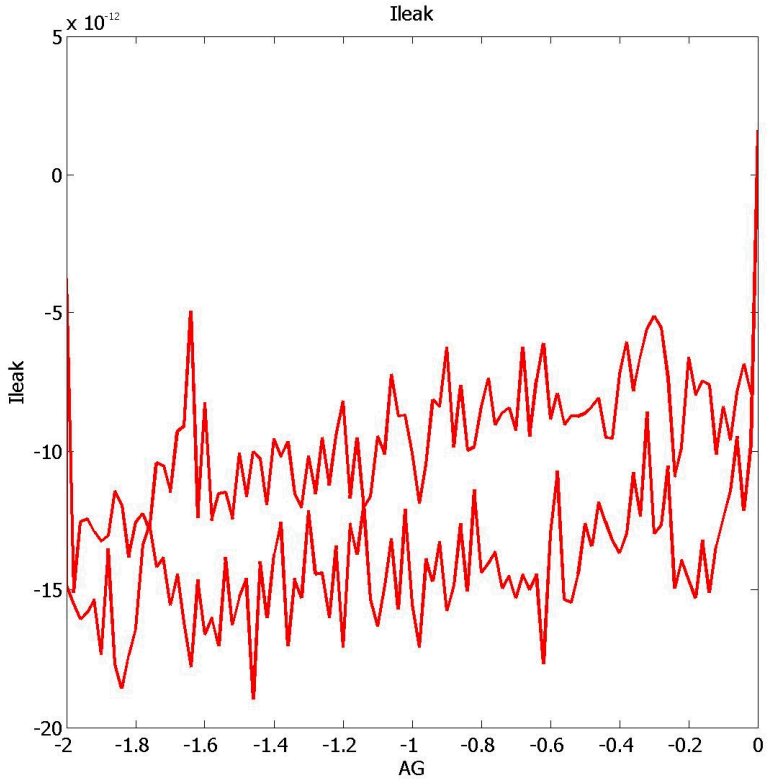
- T=4K
- All measurements were done by sweeping the voltage up and down over the same range. Both directions are plotted on top of each other in all the plots shown on subsequent pages.
- AG = 0 – 2V for most sweeps. -2V – 0V for determining the threshold voltage.
- Vsd =1mV for the contact being investigated. The other 5 ohmic contacts are grounded. Source-drain current, Isd, and gate leakage, Ileak, are measured.



# 1410UL

No leakage current within AG=+-2V.
The overall amplitude is very small and close to the limit of the instrument.
The small difference in current for the two sweeps arises from displacement current for different polarities.

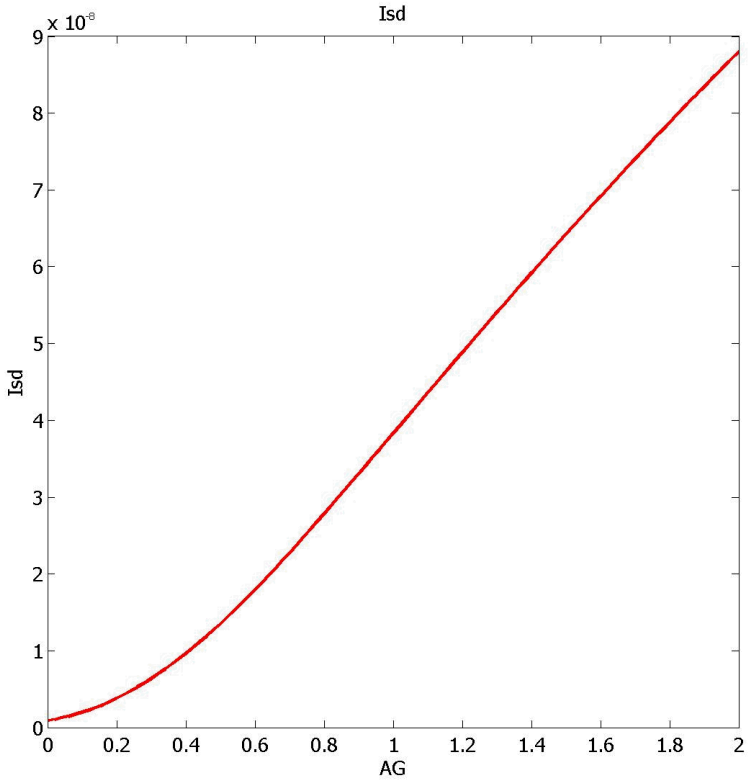


# 1410UL

Conductance is modulated by AG as expected.
Current amplitude is ~ expected.
Finite conductance at AG=0V. (negative threshold)
Difference between different contacts is small.

Contact#1

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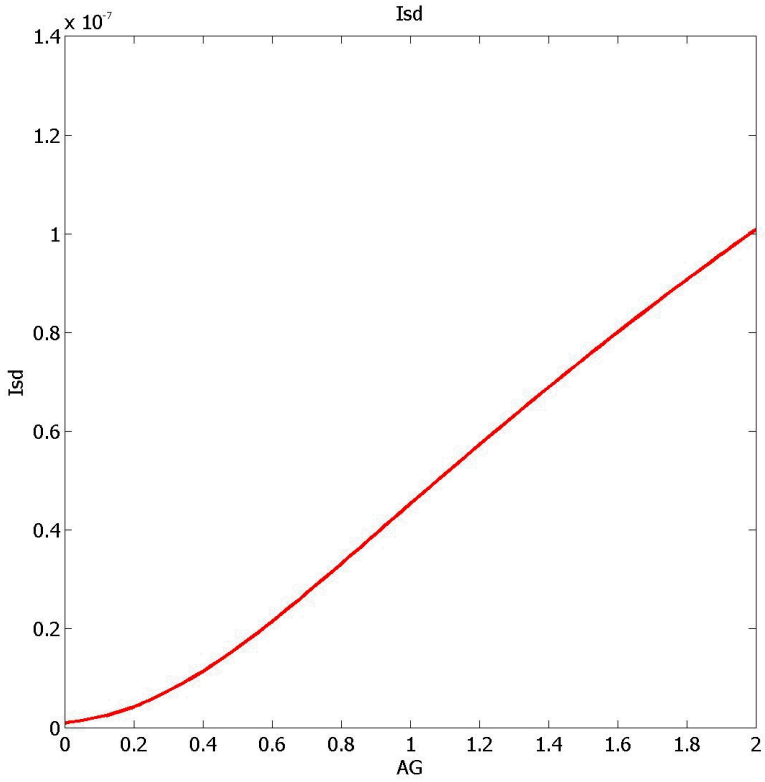
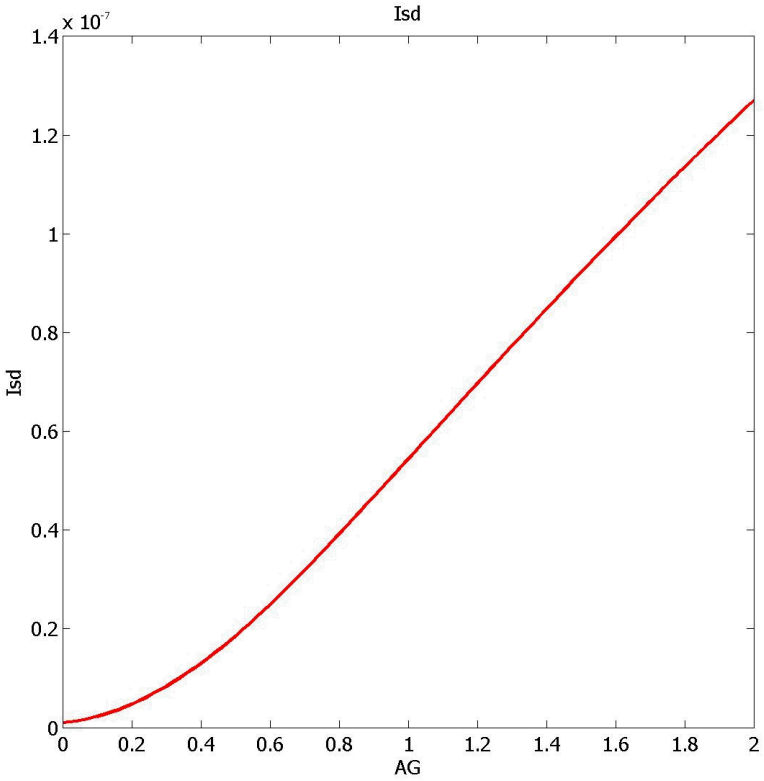


# 1410UL

Conductance is modulated by AG as expected.
Current amplitude is ~ expected.
Finite conductance at AG=0V. (negative threshold)
Difference between different contacts is small.

Contact#3

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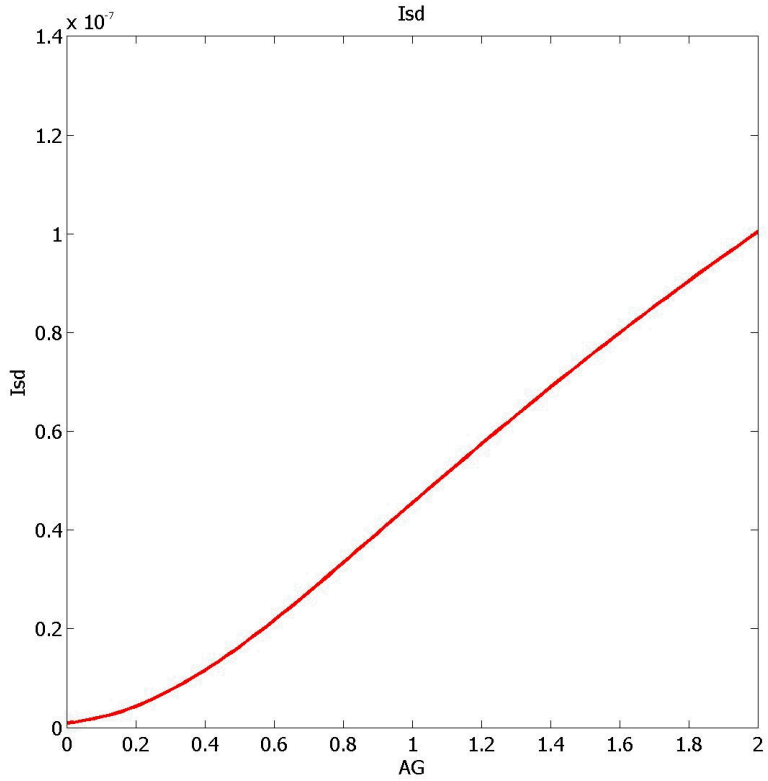
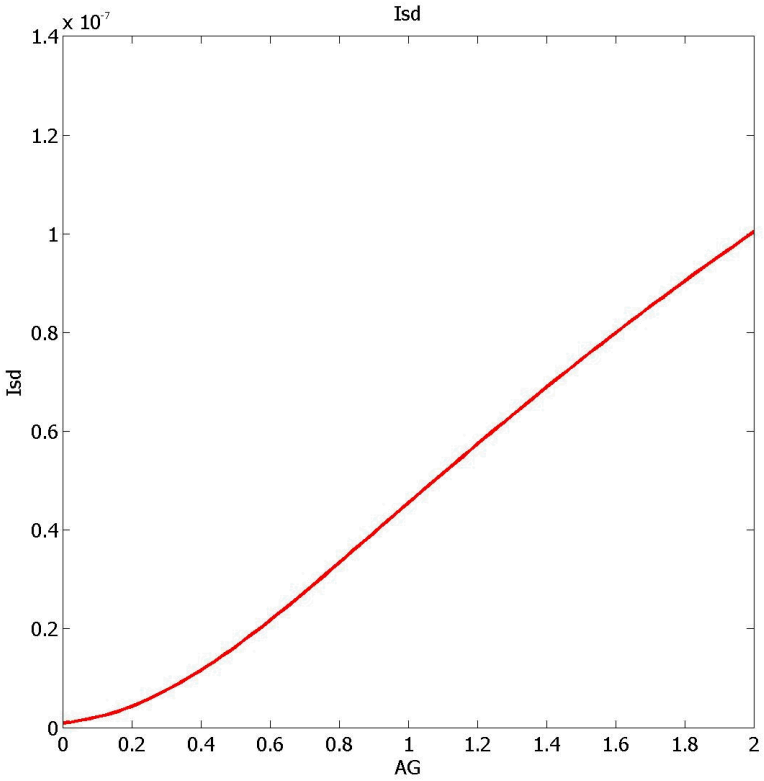


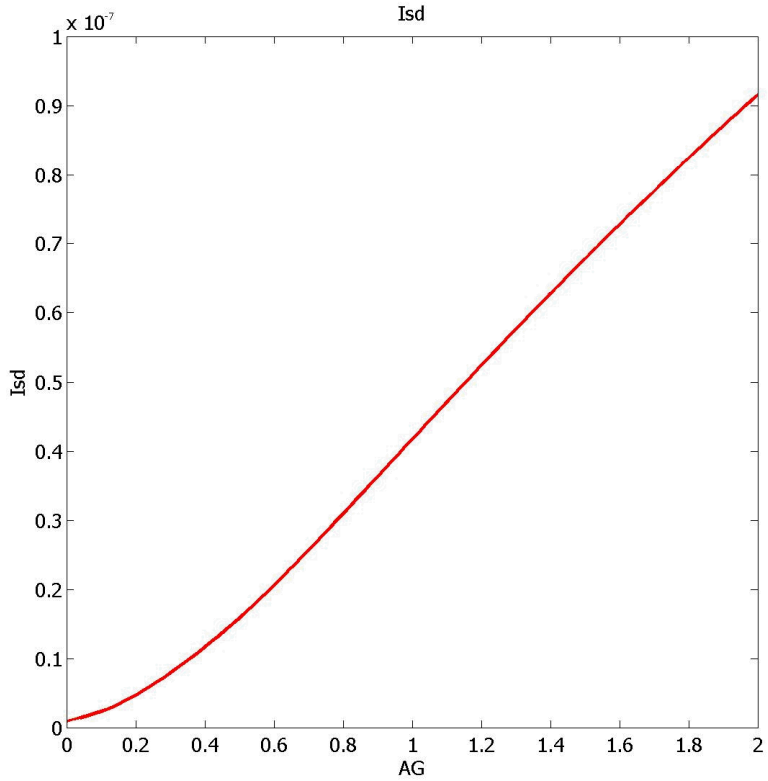
# 1410UL

Conductance is modulated by AG as expected.
Current amplitude is ~ expected.
Finite conductance at AG=0V. (negative threshold)
Difference between different contacts is small.

Contact#5



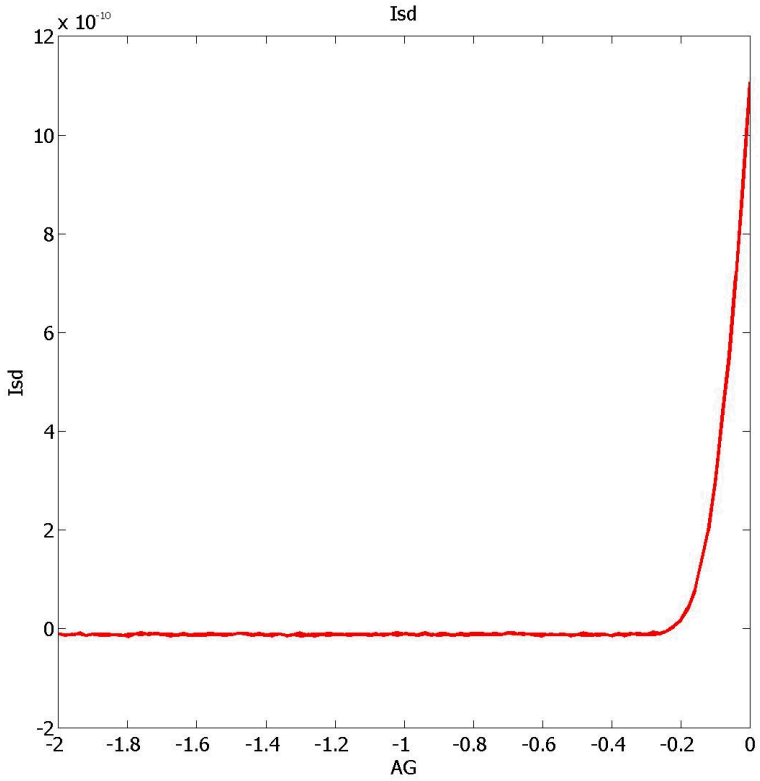

Contact#6



# 1410UL

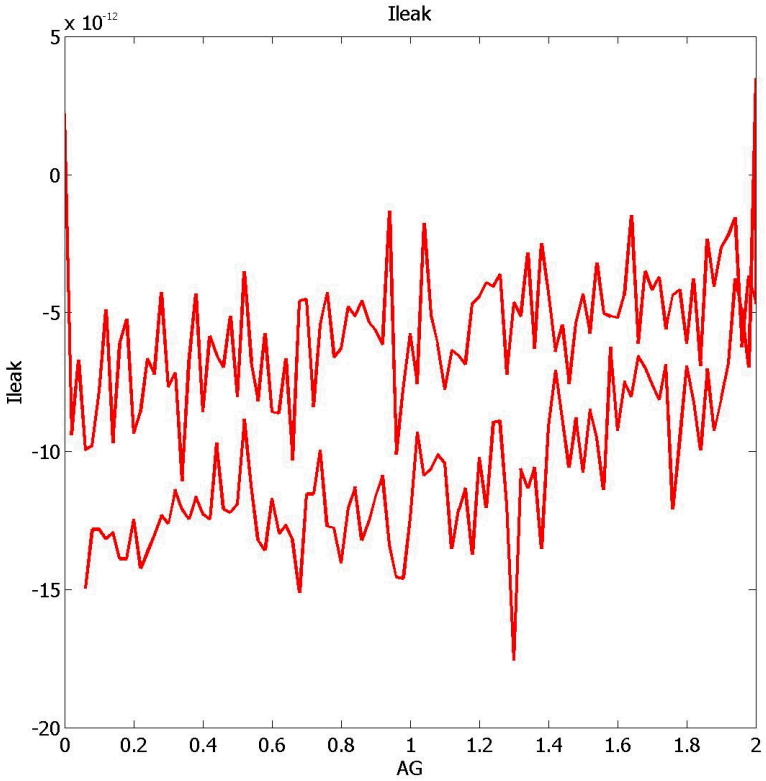
Conductance is modulated by AG.
Finite conductance at AG=0V.
Vt ~ -0.2V.

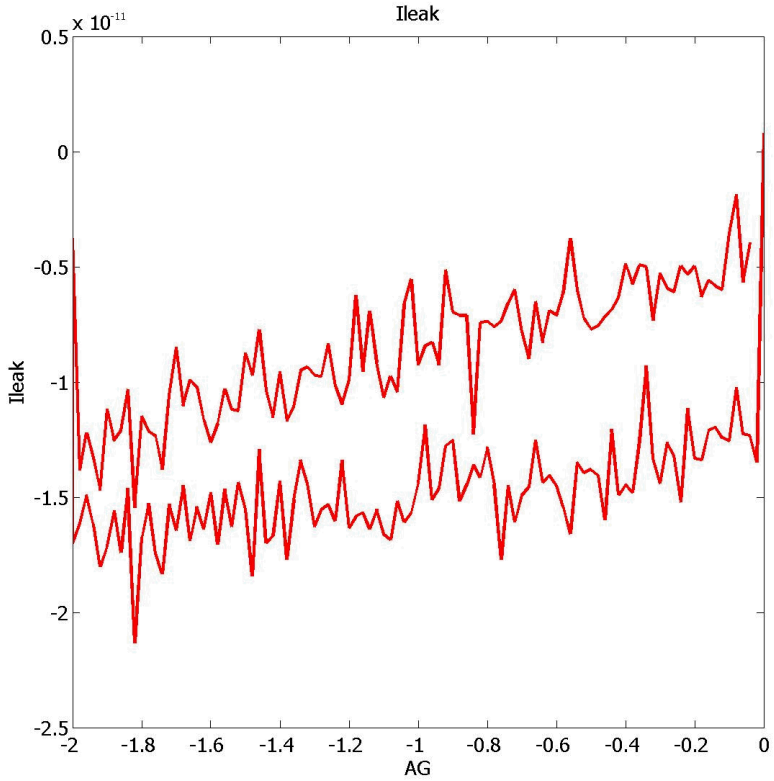
Contact#6



# 1410UR

No leakage current within AG=+-2V.
The overall amplitude is very small and close to the limit of the instrument.
The small difference in current for the two sweeps arises from displacement current for different polarities.

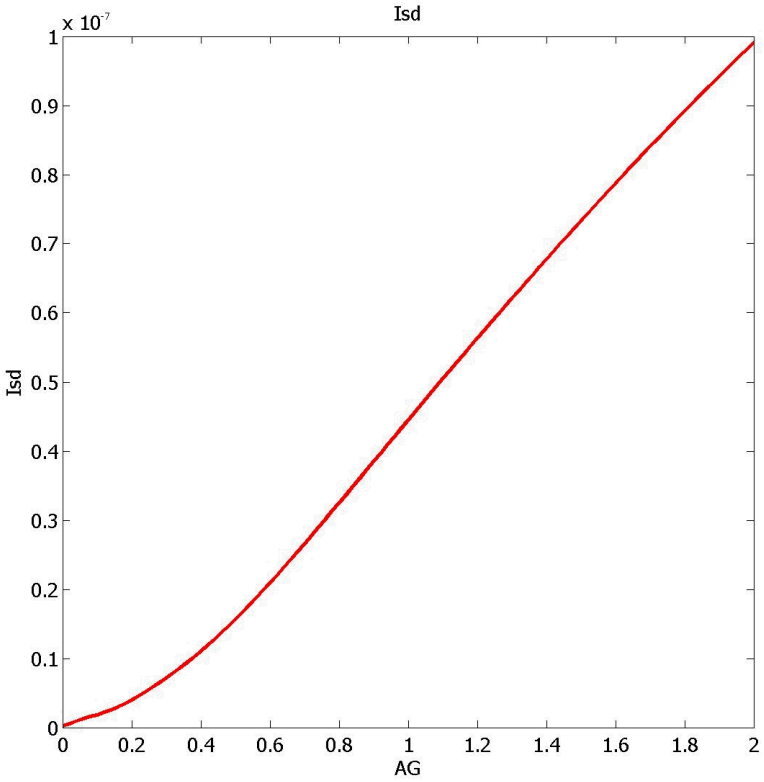


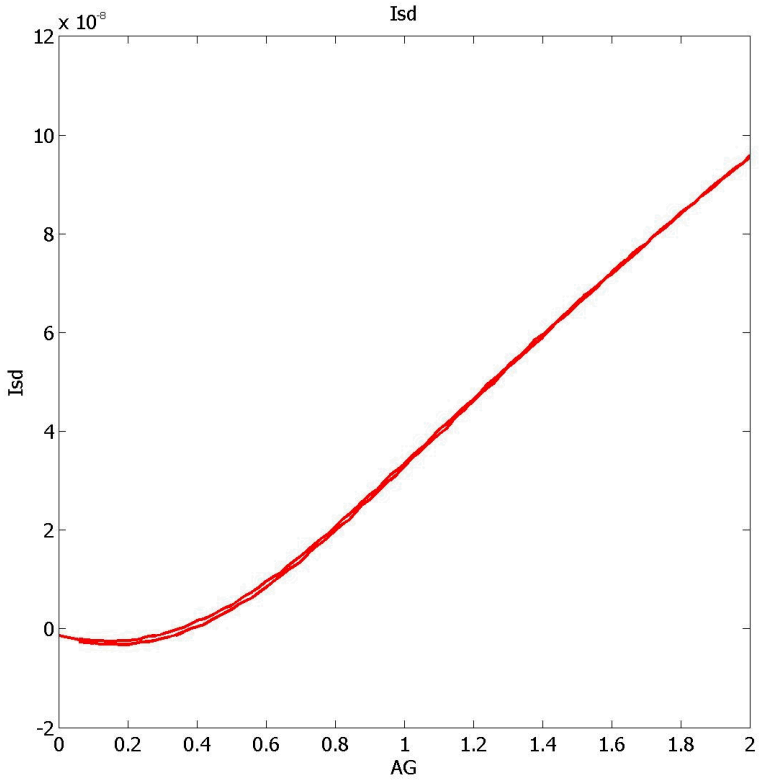
# 1410UR

Conductance is modulated by AG as expected.
Current amplitude is ~ expected.
Finite conductance at AG=0V. (negative threshold)
Difference between different contacts is small.

Contact#1



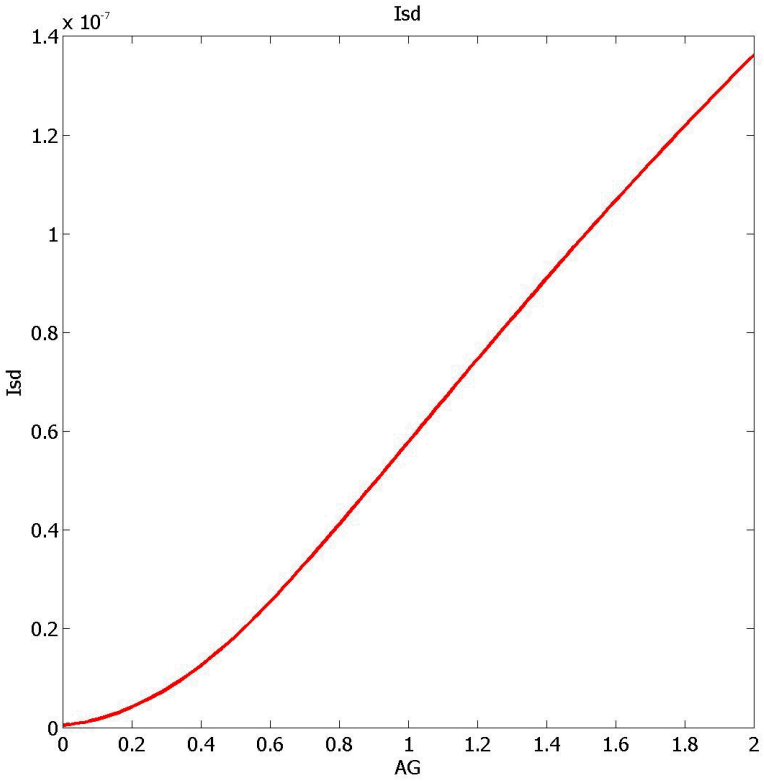

Contact#2



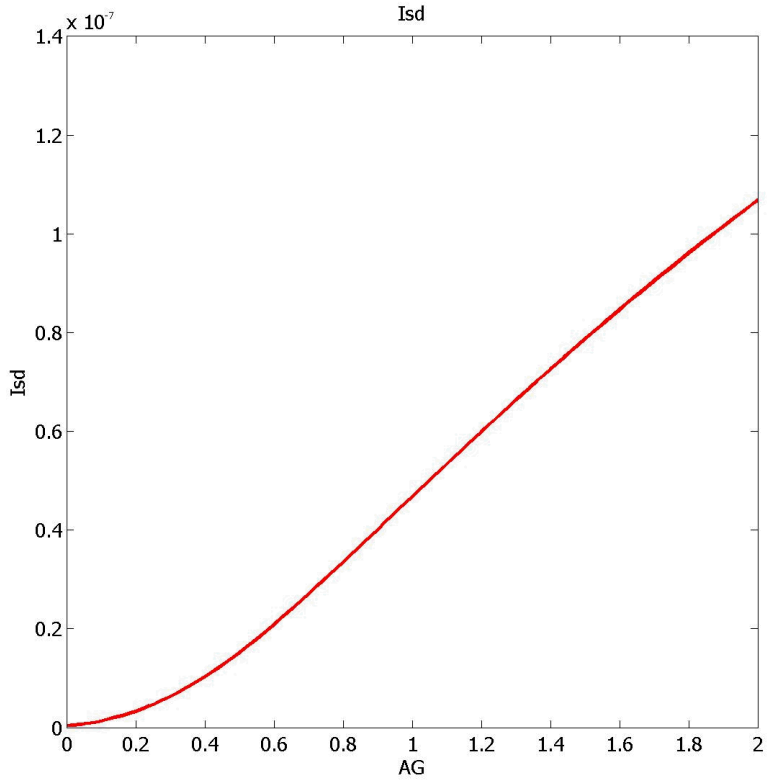
# 1410UR

Conductance is modulated by AG as expected.
Current amplitude is ~ expected.
Finite conductance at AG=0V. (negative threshold)
Difference between different contacts is small.

Contact#3



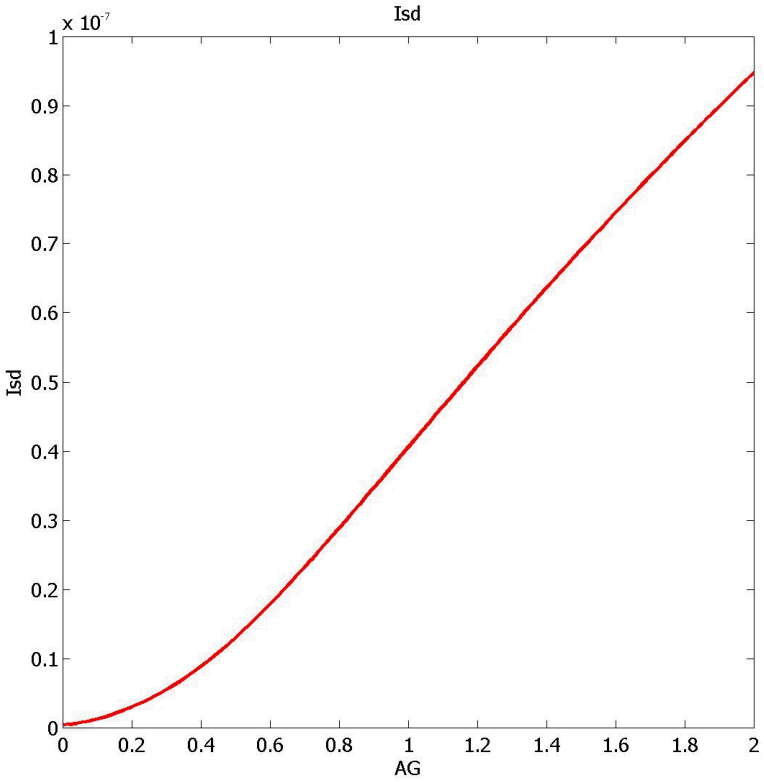

Contact#4



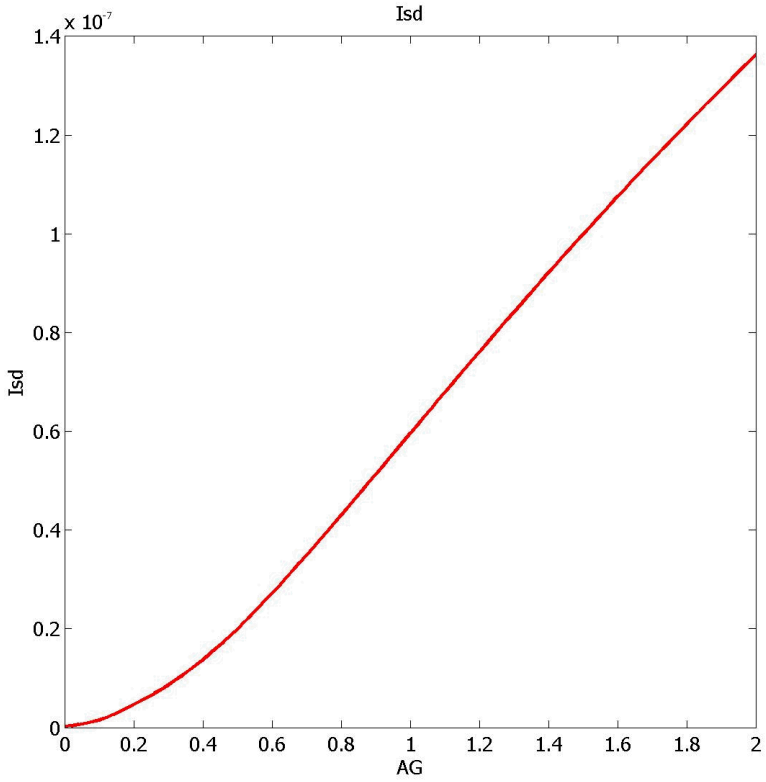
# 1410UR

Conductance is modulated by AG as expected.
Current amplitude is ~ expected.
Finite conductance at AG=0V. (negative threshold)
Difference between different contacts is small.

Contact#5



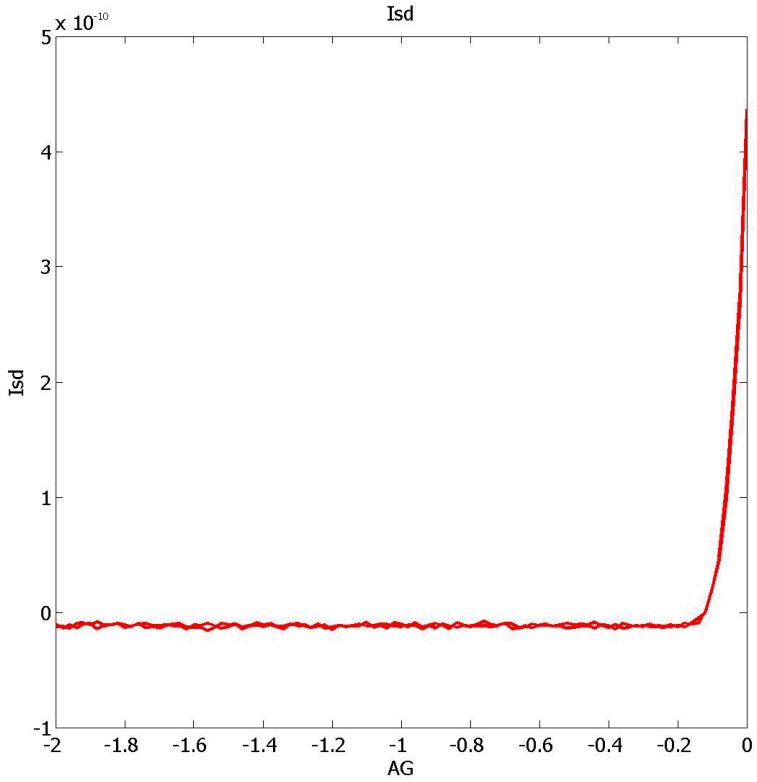

Contact#6



# 1410UR

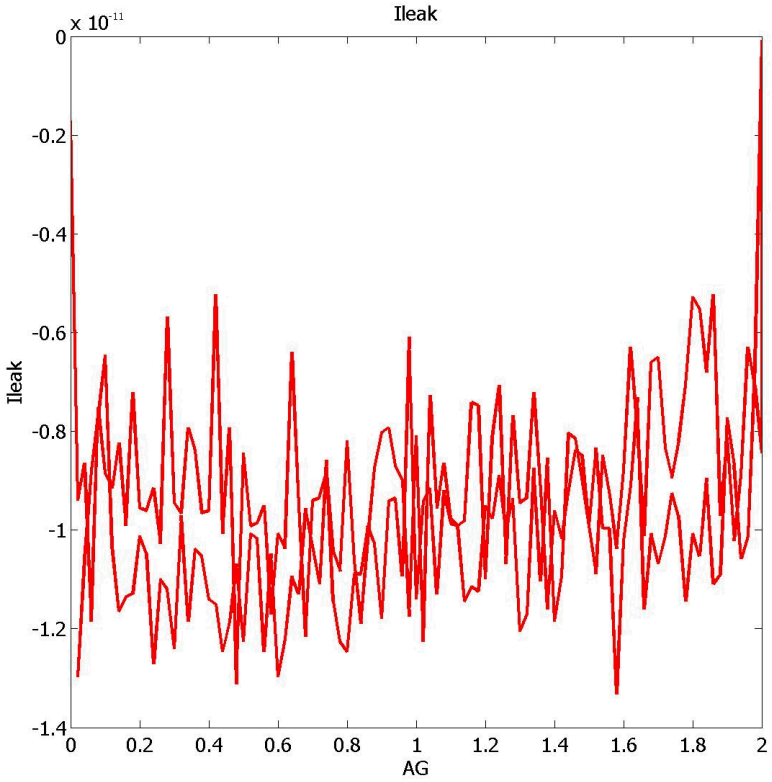
Conductance is modulated by AG.
Finite conductance at AG=0V.
Vt ~ -0.1V.

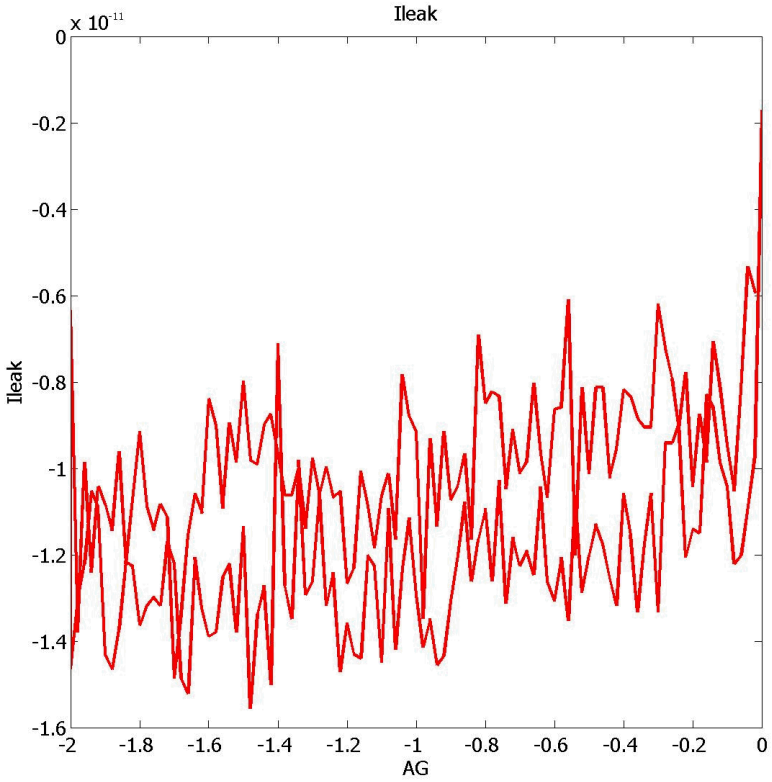
Contact#3



# 1411LR

No leakage current within AG=+-2V.
The overall amplitude is very small and close to the limit of the instrument.
The small difference in current for the two sweeps arises from displacement current for different polarities.

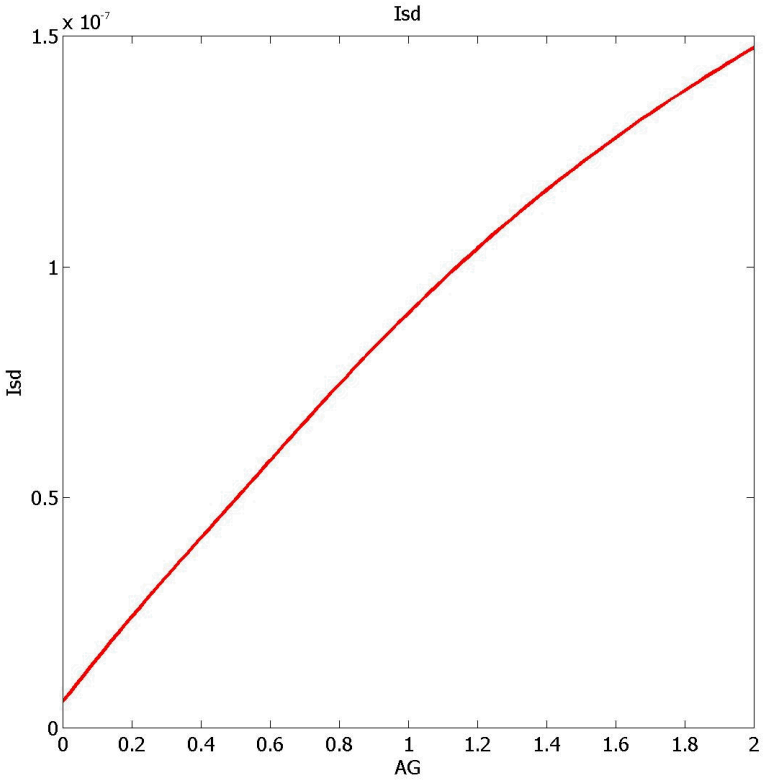


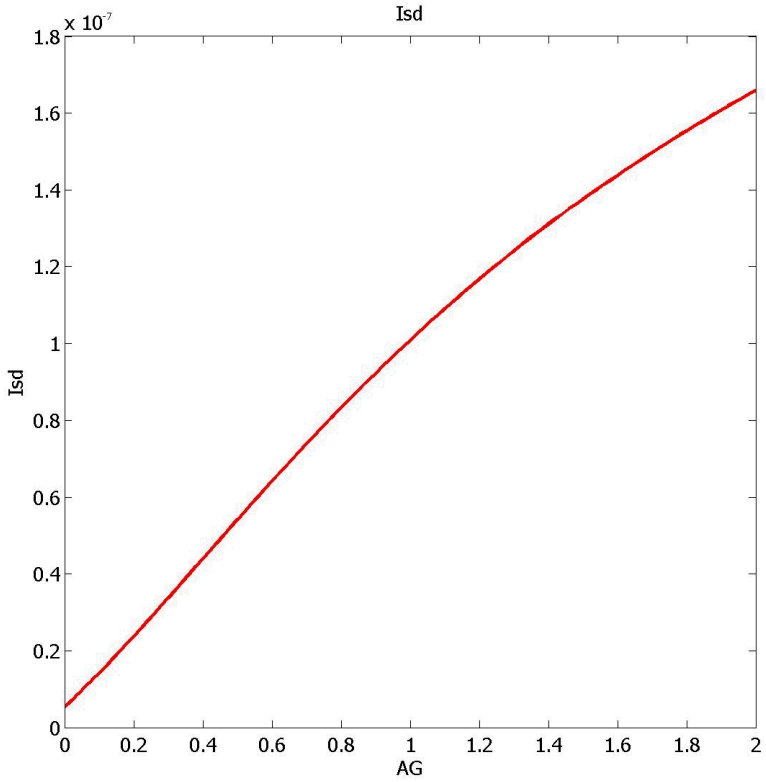
# 1411LR

Conductance is modulated by AG as expected.
Current amplitude is ~ expected.
Finite conductance at AG=0V. (negative threshold)
Difference between different contacts is small.

Contact#1



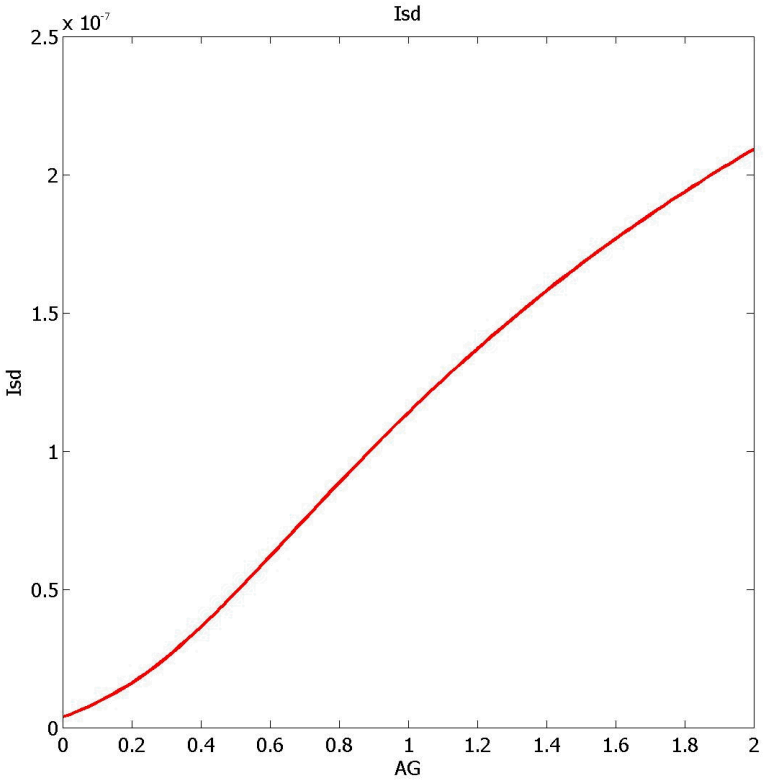

Contact#2



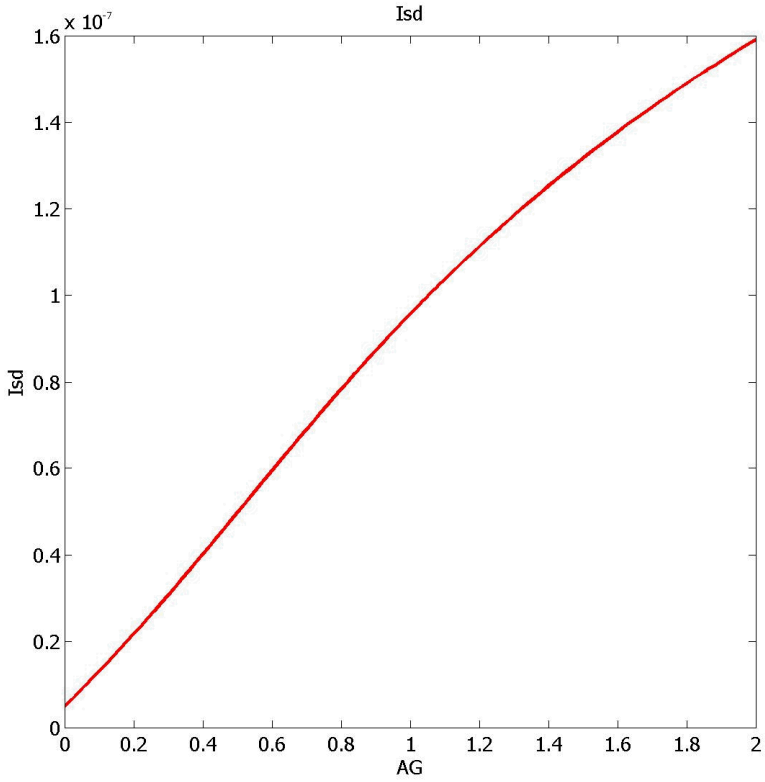
# 1411LR

Conductance is modulated by AG as expected.
Current amplitude is ~ expected.
Finite conductance at AG=0V. (negative threshold)
Difference between different contacts is small.

Contact#3



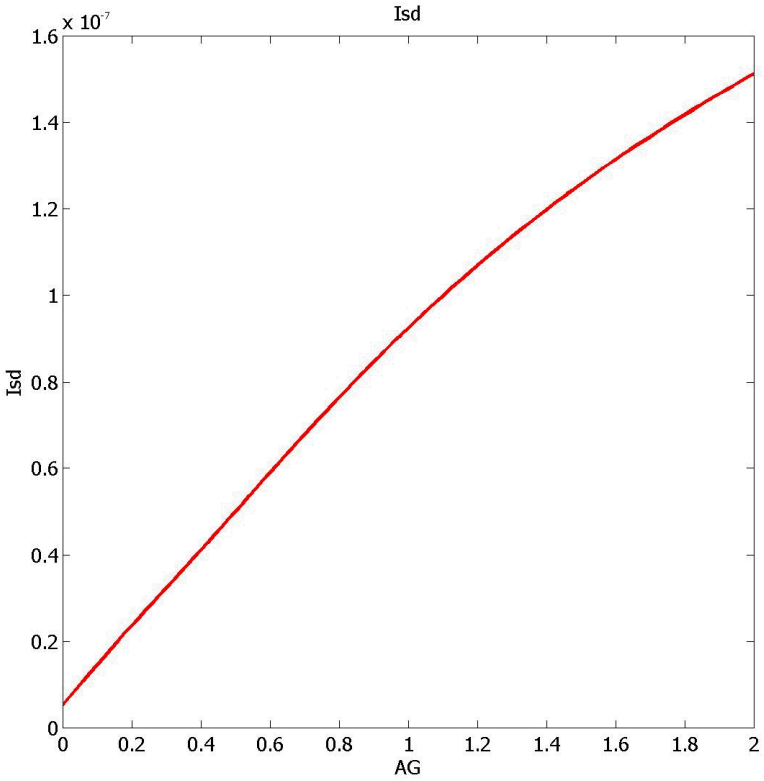

Contact#4



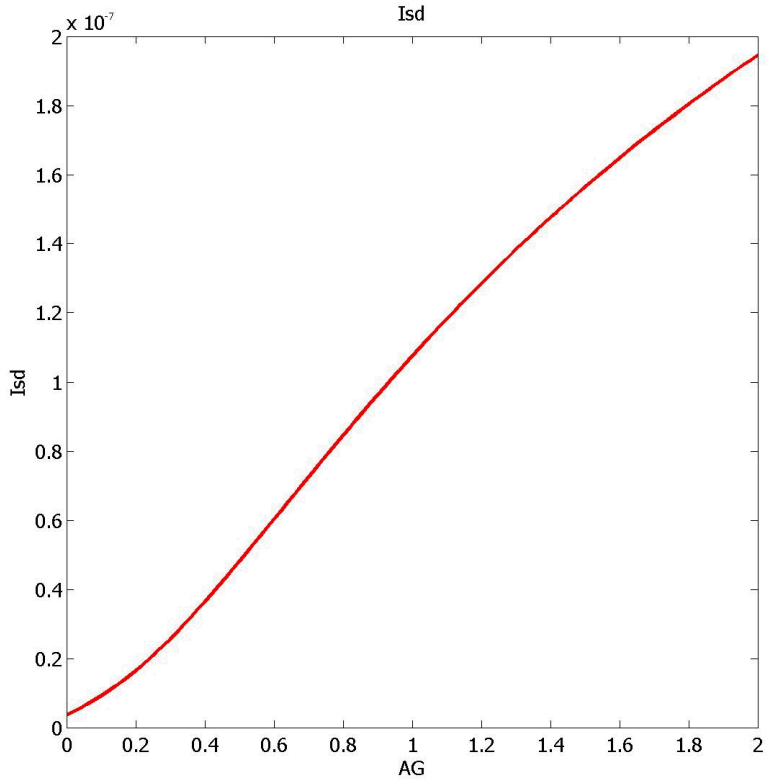
# 1411LR

Conductance is modulated by AG as expected.
Current amplitude is ~ expected.
Finite conductance at AG=0V. (negative threshold)
Difference between different contacts is small.

Contact#5



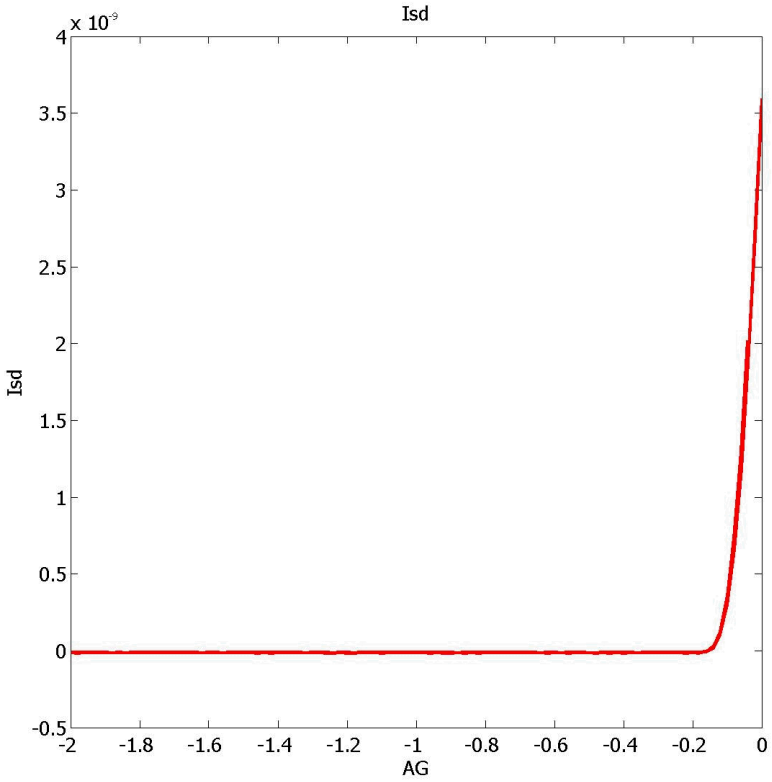

Contact#6



# 1411LR

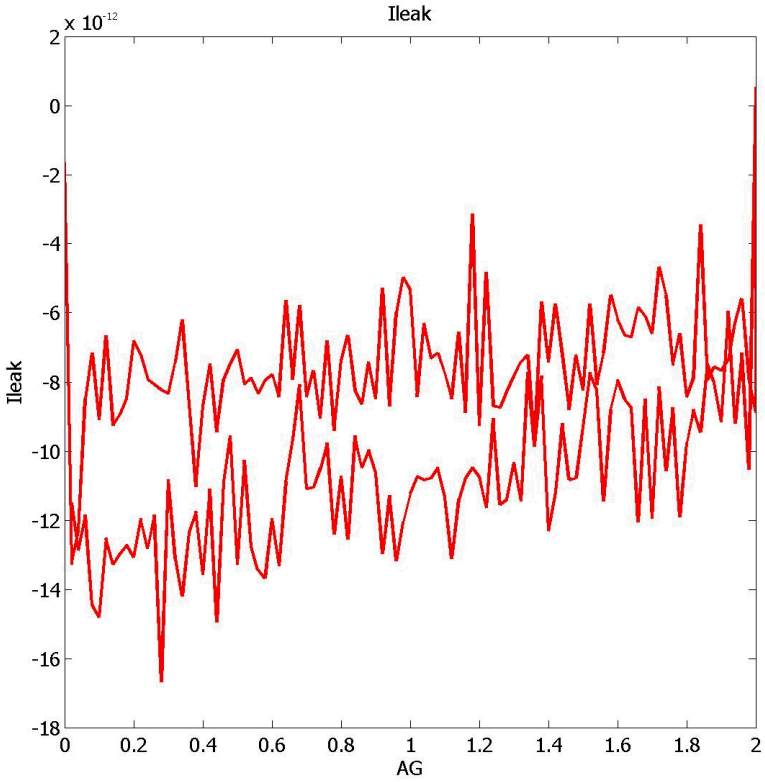
Conductance is modulated by AG.
Finite conductance at AG=0V.
Vt ~ -0.1V.

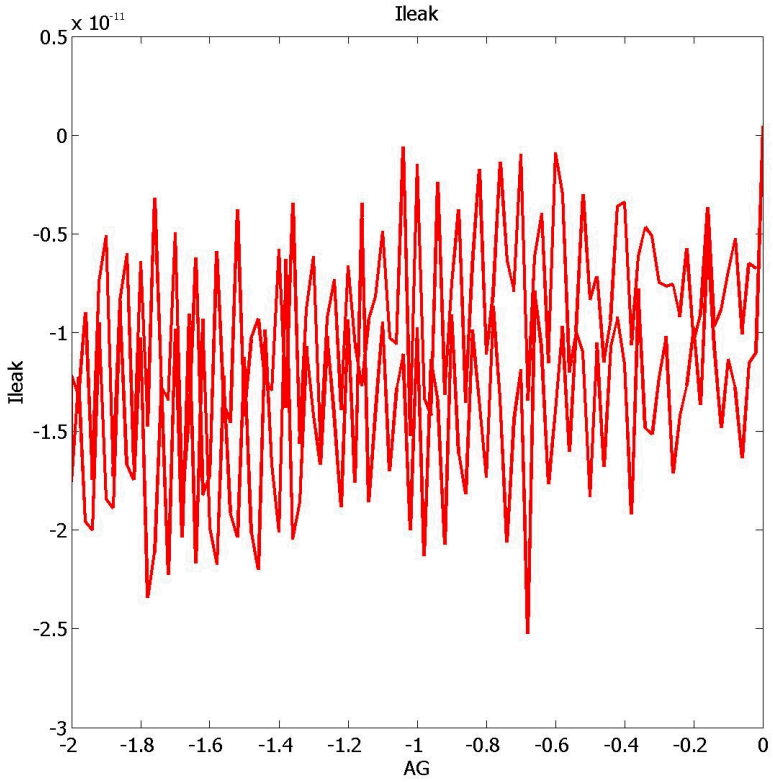
Contact#6



# 1411LL

No leakage current within AG=+-2V.
The overall amplitude is very small and close to the limit of the instrument.
The small difference in current for the two sweeps arises from displacement current for different polarities.

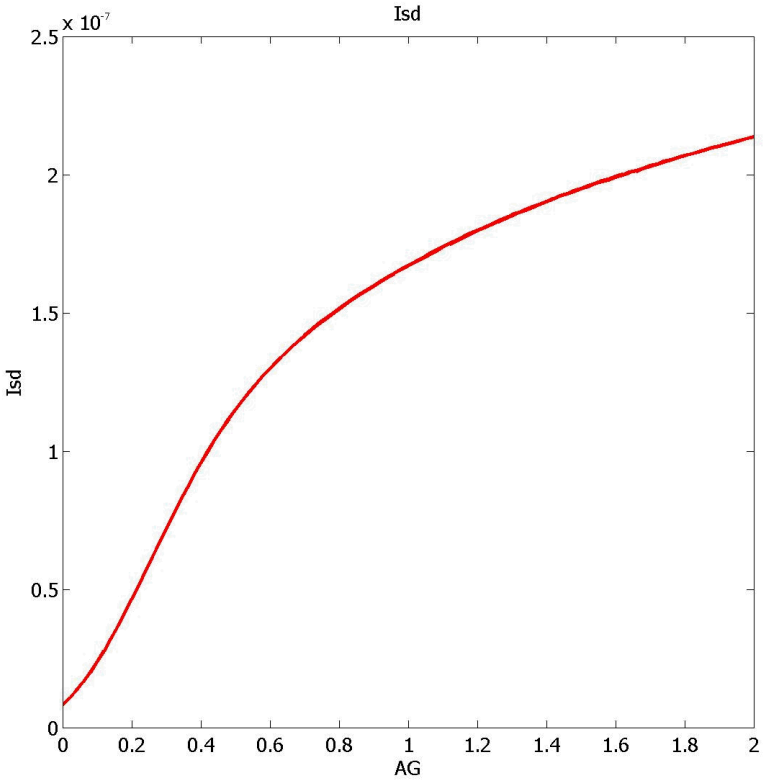


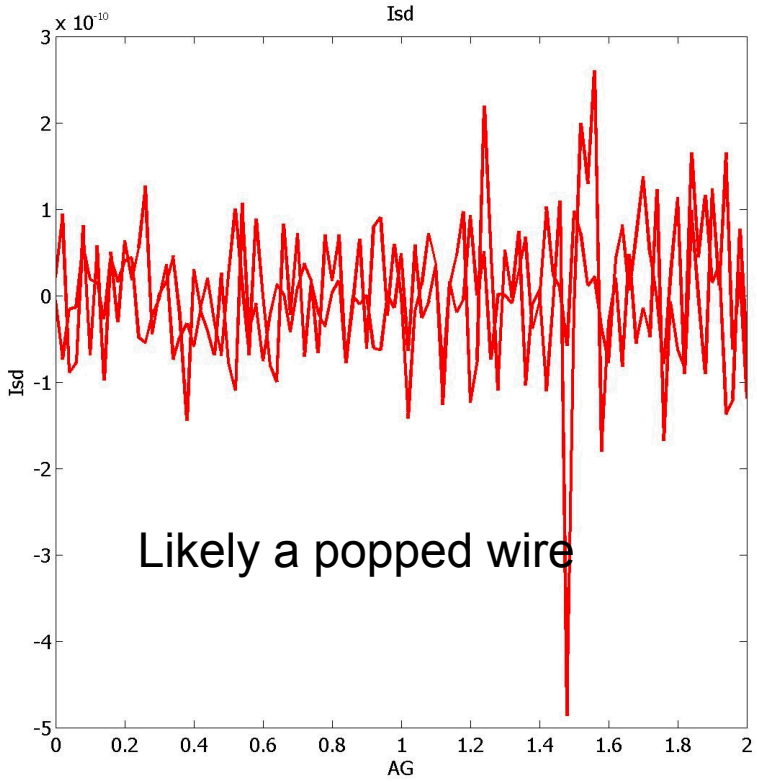
# 1411LL

Conductance is modulated by AG as expected.
Current amplitude is ~ expected.
Finite conductance at AG=0V. (negative threshold)
Difference between different contacts is small.

Contact#1



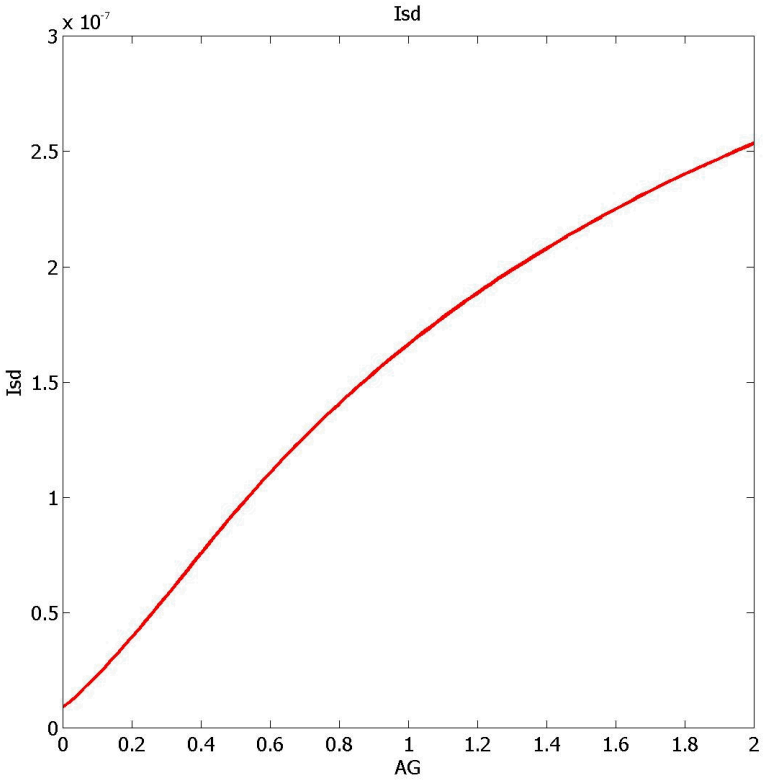

Contact#2



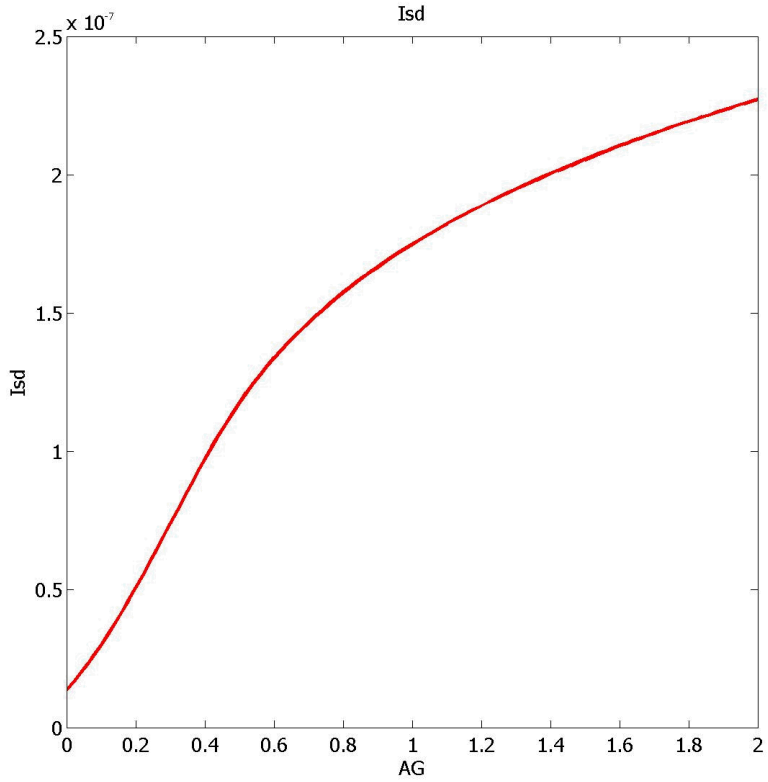
# 1411LL

Conductance is modulated by AG as expected.
Current amplitude is ~ expected.
Finite conductance at AG=0V. (negative threshold)
Difference between different contacts is small.

Contact#3



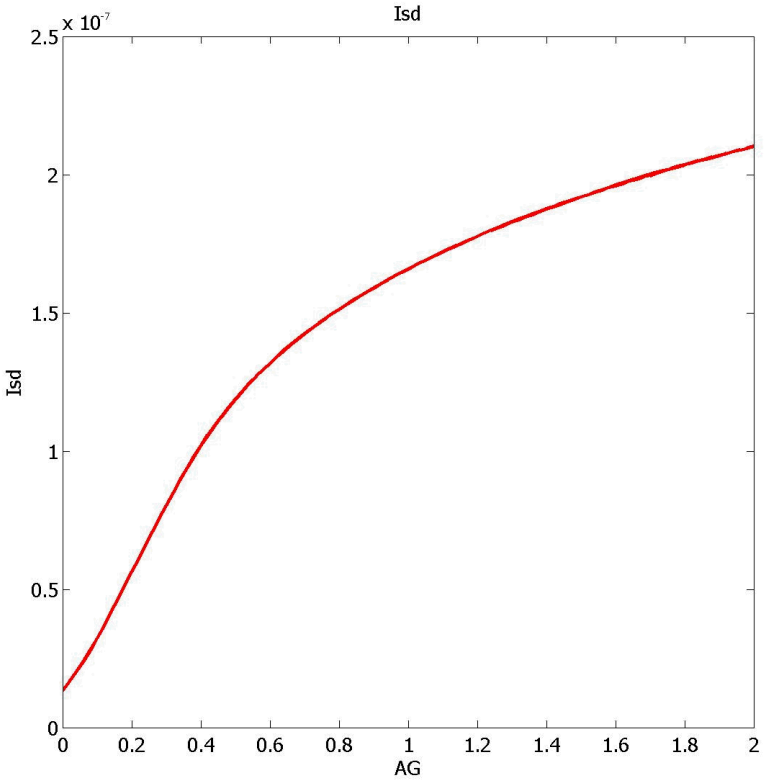

Contact#4



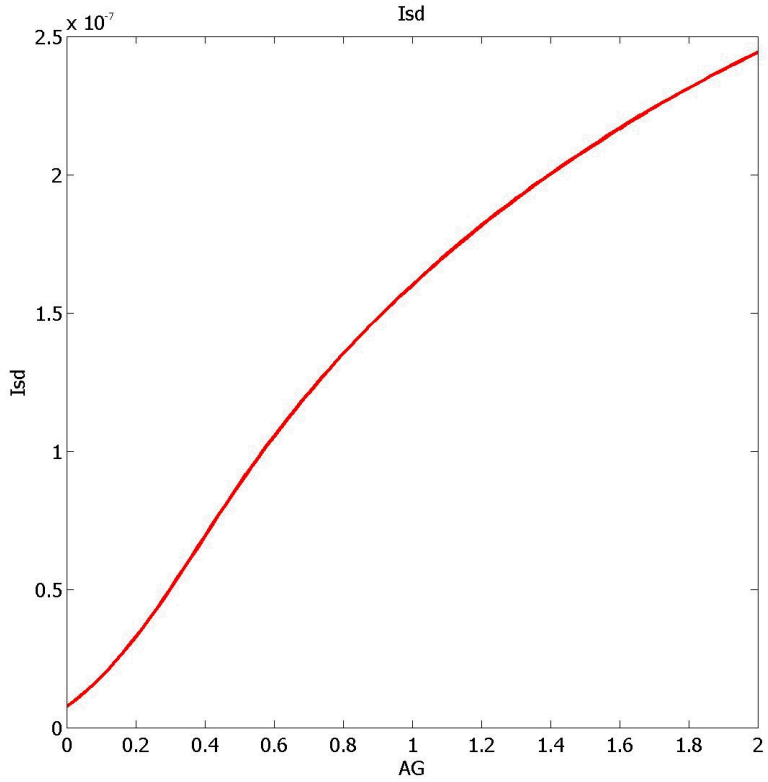
# 1411LL

Conductance is modulated by AG as expected.
Current amplitude is ~ expected.
Finite conductance at AG=0V. (negative threshold)
Difference between different contacts is small.

Contact#5



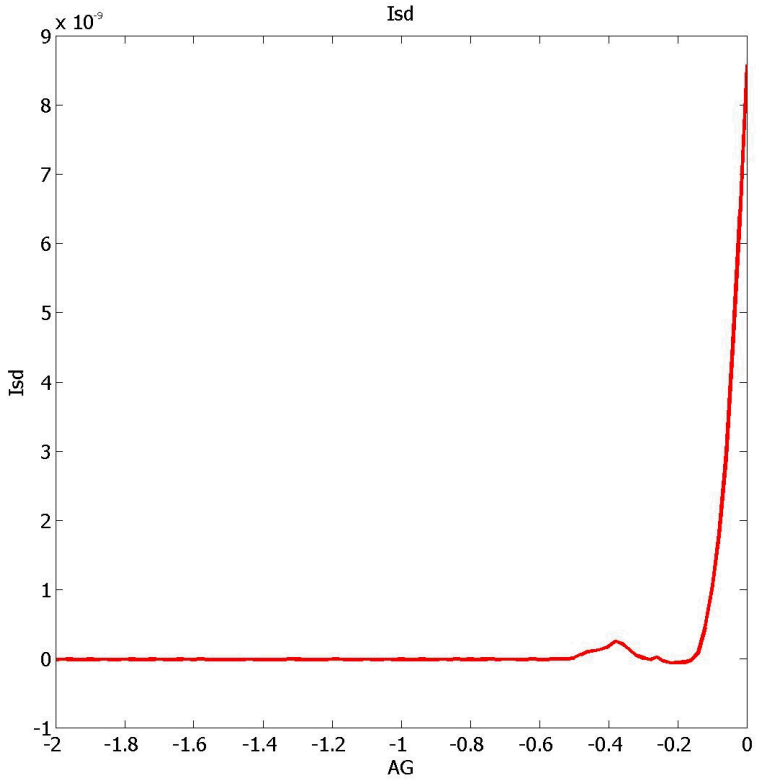

Contact#6



# 1411LR

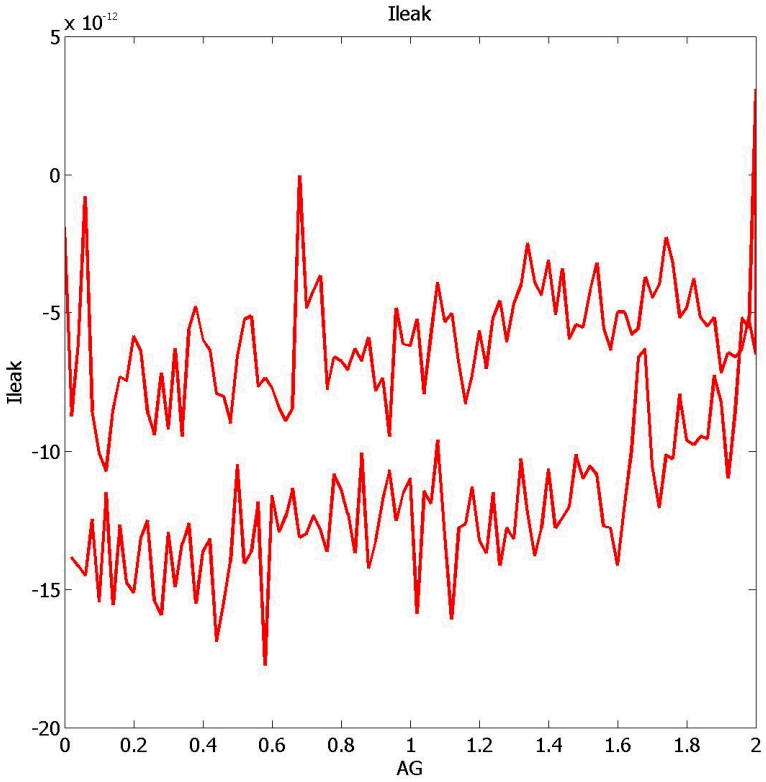
Conductance is modulated by AG.
Finite conductance at AG=0V.
Vt ~ -0.1V, with a bump at -0.4V.

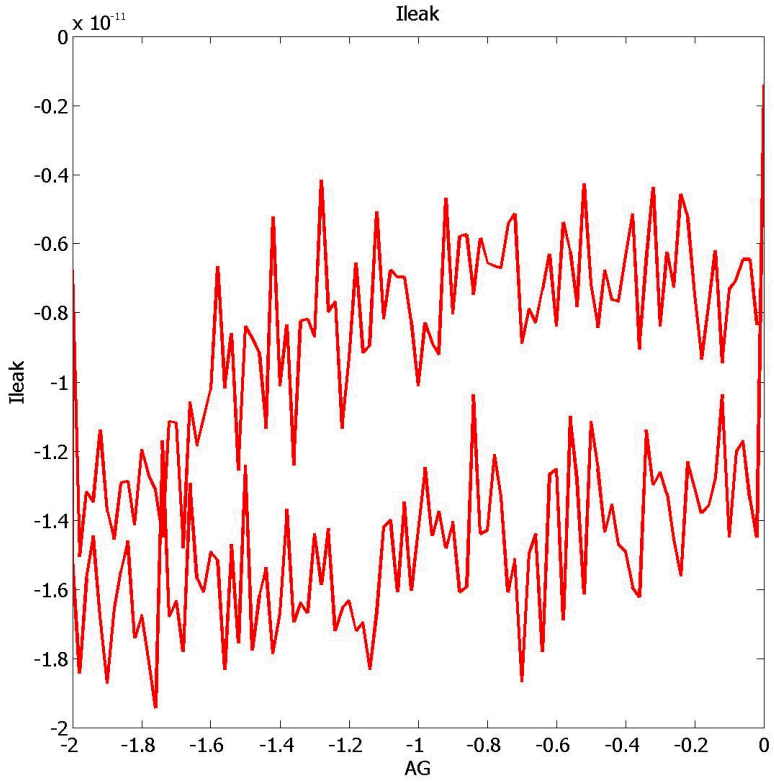
Contact#3



# 1412UL

No leakage current within AG=+-2V.
The overall amplitude is very small and close to the limit of the instrument.
The small difference in current for the two sweeps arises from displacement current for different polarities.

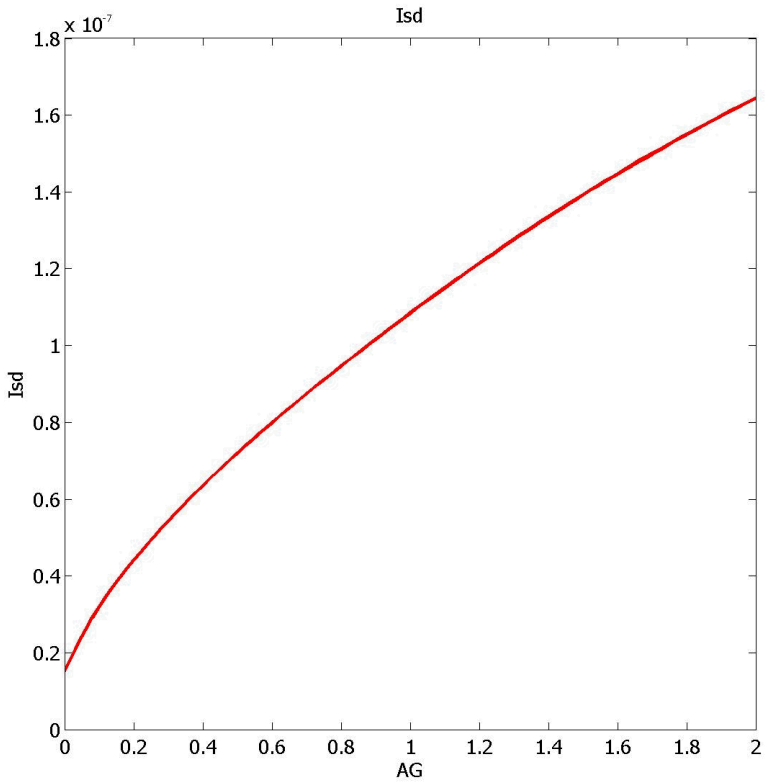


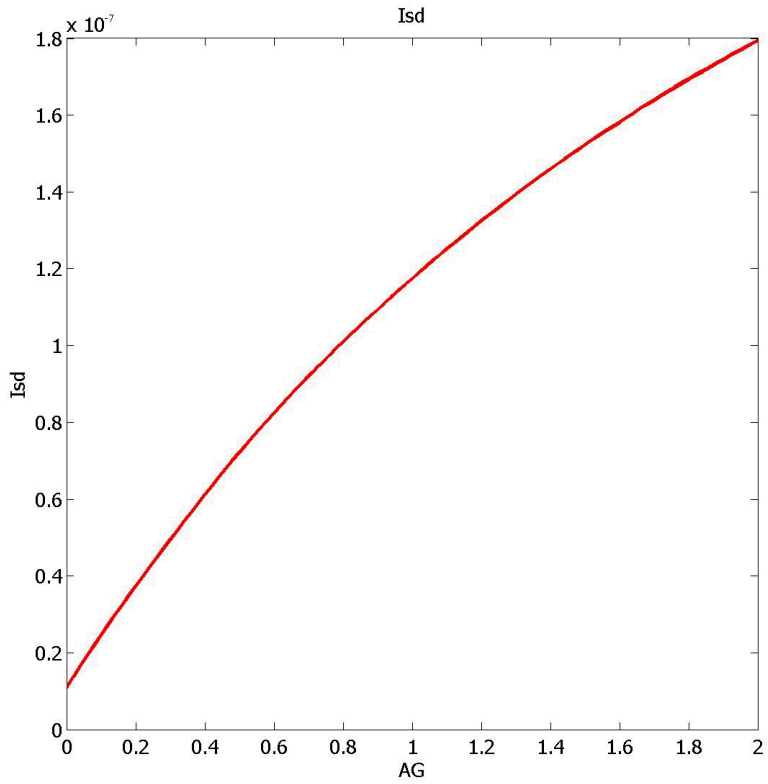
# 1412UL

Conductance is modulated by AG as expected.
Current amplitude is ~ expected.
Finite conductance at AG=0V. (negative threshold)
Difference between different contacts is small.

Contact#1



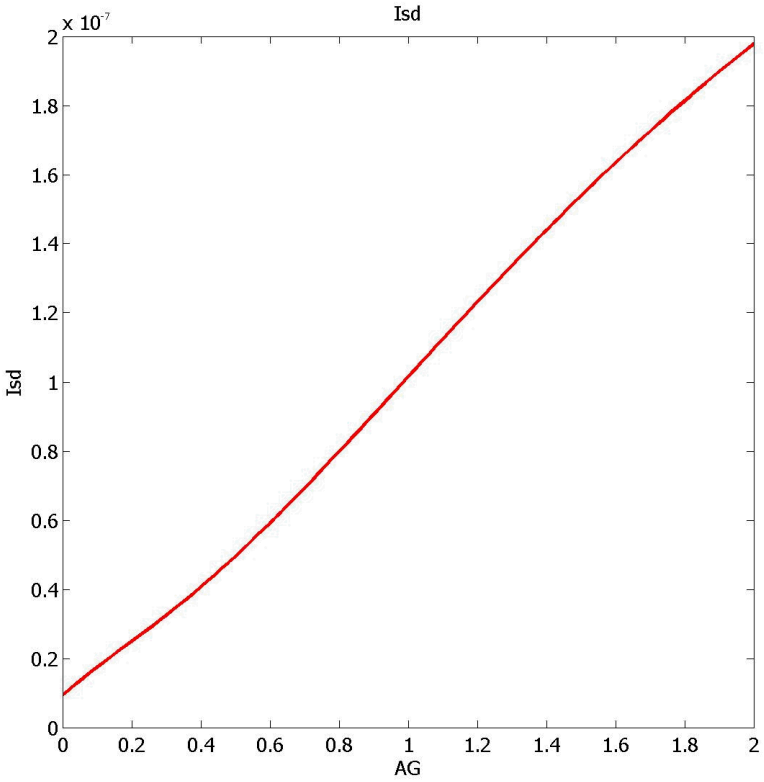

Contact#2



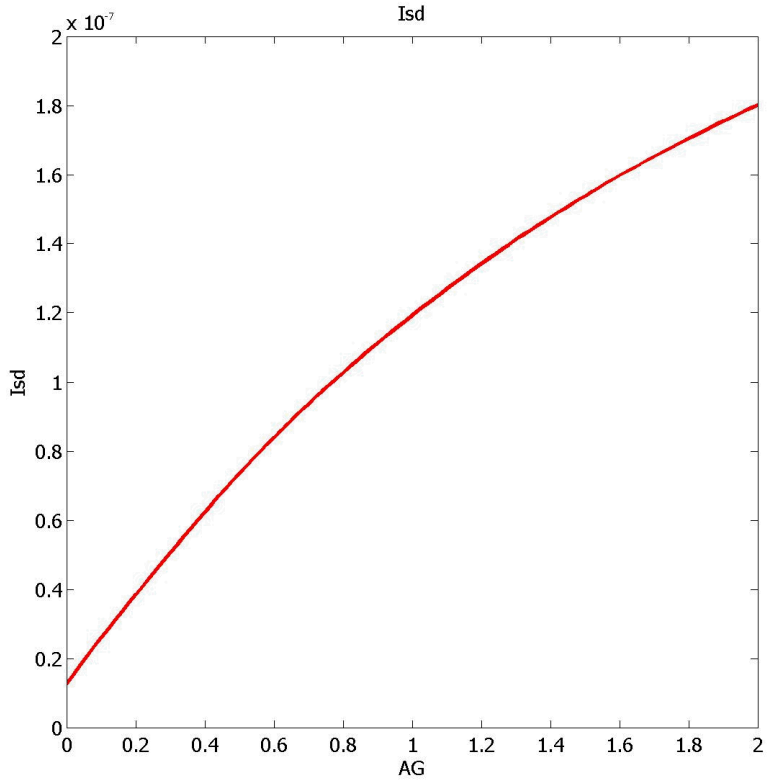
# 1412UL

Conductance is modulated by AG as expected.
Current amplitude is ~ expected.
Finite conductance at AG=0V. (negative threshold)
Difference between different contacts is small.

Contact#3



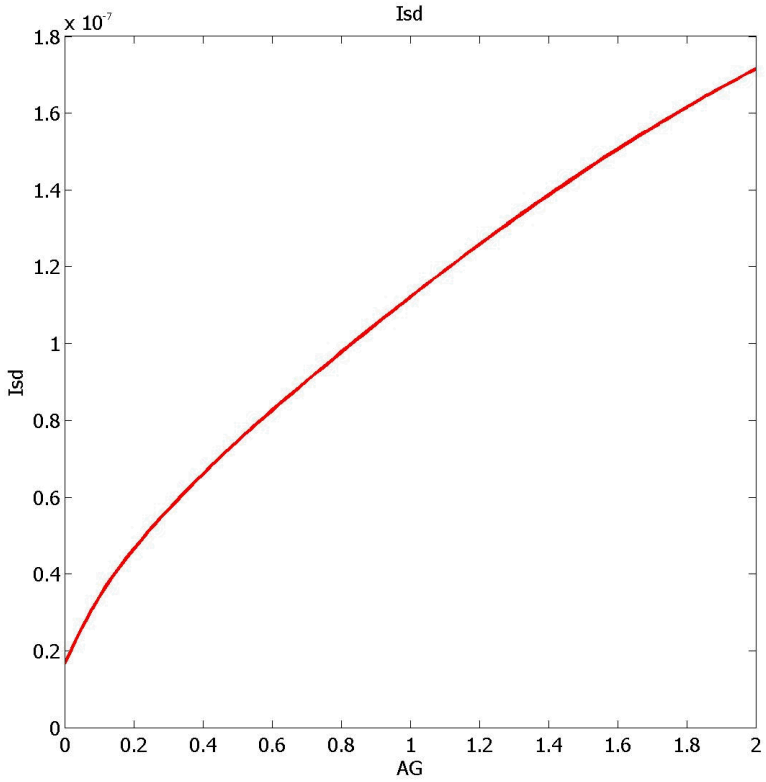

Contact#4



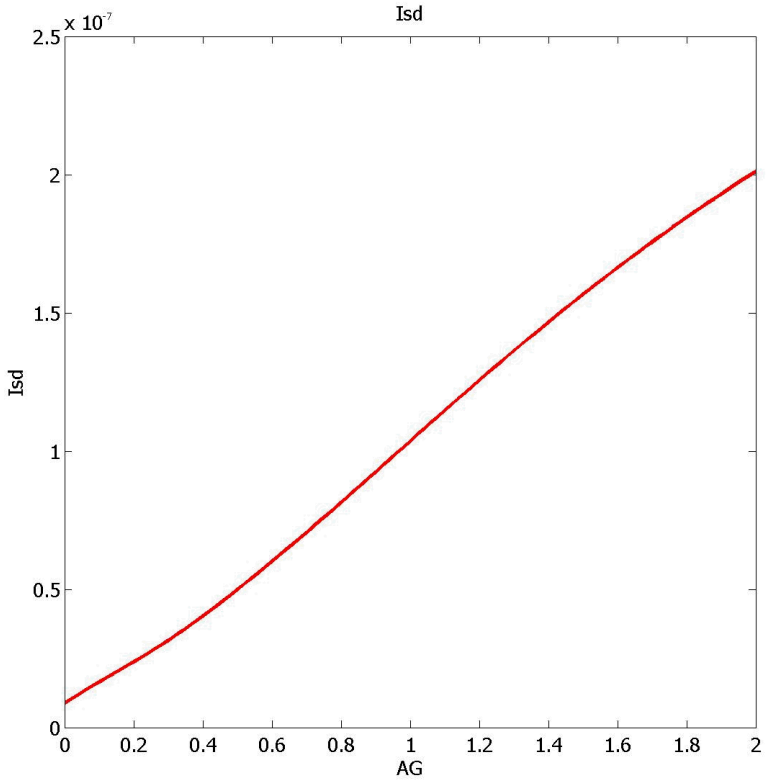
# 1412UL

Conductance is modulated by AG as expected.
Current amplitude is ~ expected.
Finite conductance at AG=0V. (negative threshold)
Difference between different contacts is small.

Contact#5



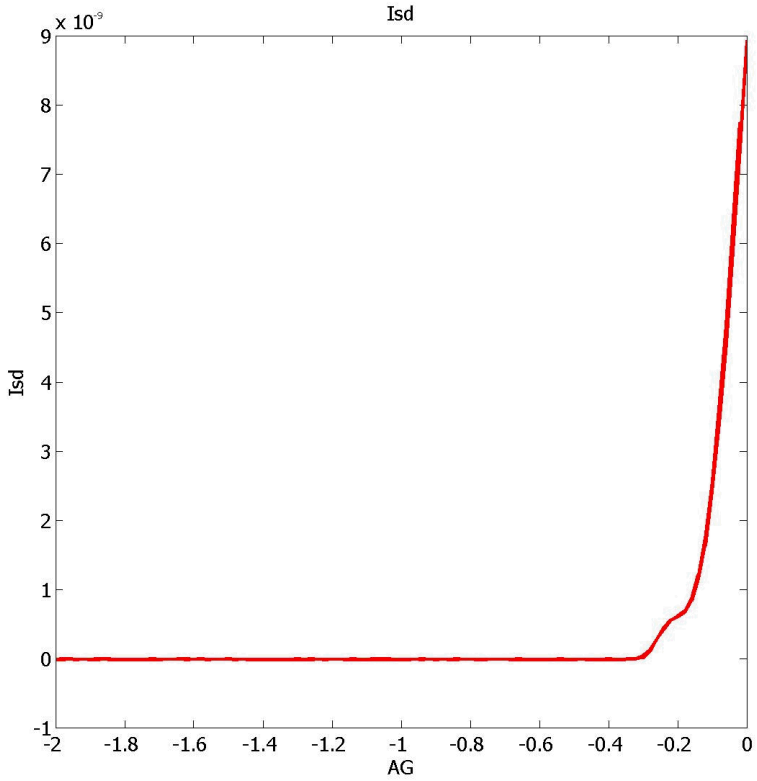

Contact#6



# 1412UL

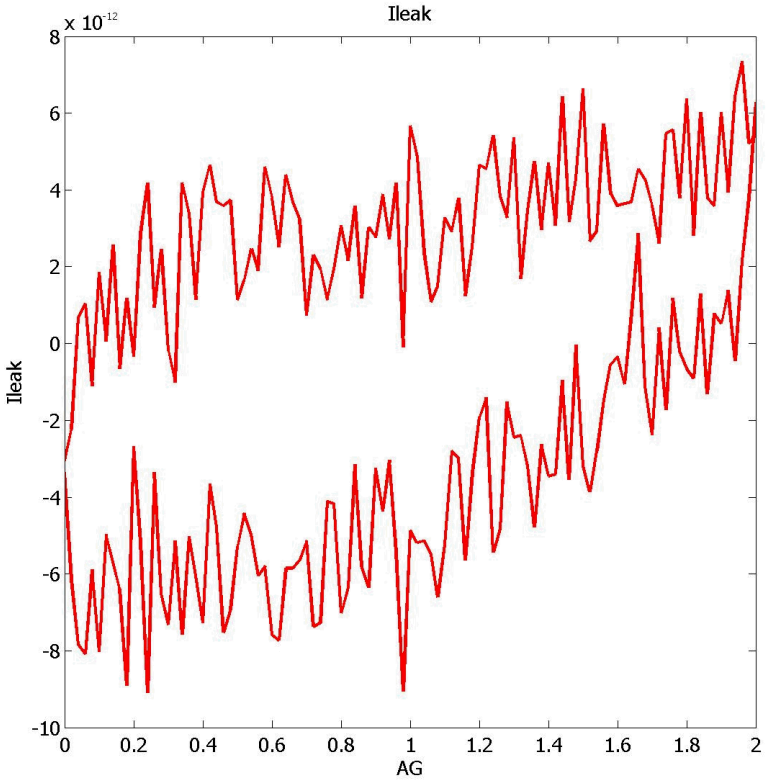
Conductance is modulated by AG.
Finite conductance at AG=0V.
Vt ~ -0.3V, with a kink at -0.2V

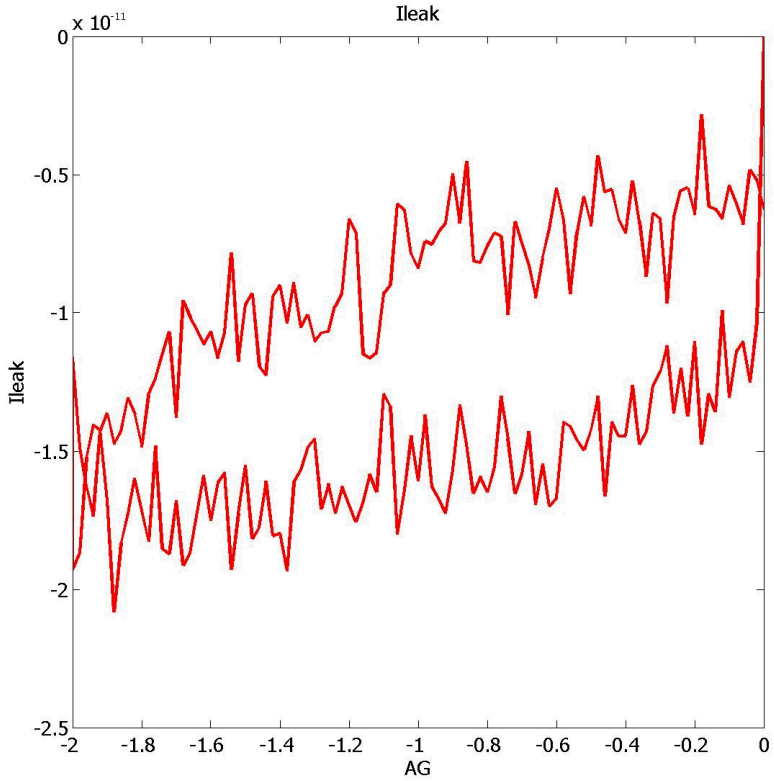
Contact#6



# 1412UR

No leakage current within AG=+-2V.
The overall amplitude is very small and close to the limit of the instrument.
The small difference in current for the two sweeps arises from displacement current for different polarities.

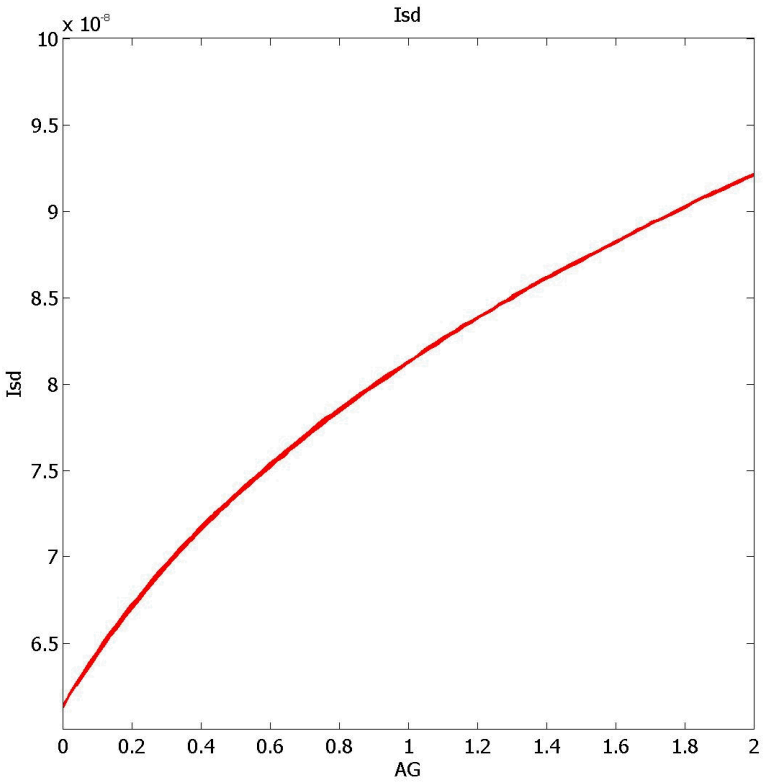


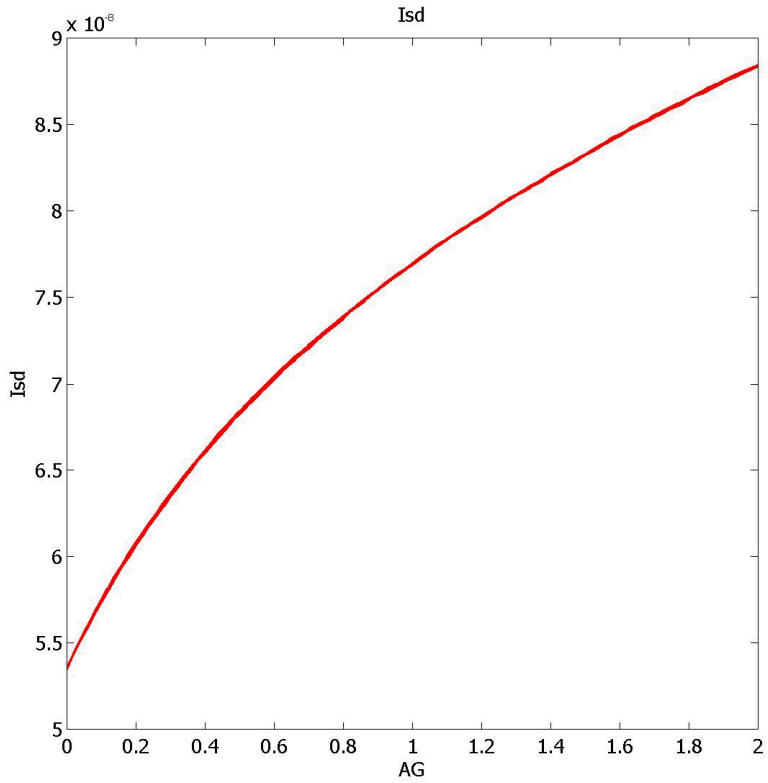
# 1412UR

Conductance is modulated by AG as expected.
Current amplitude is ~ expected.
Finite conductance at AG=0V. (negative threshold)
Difference between different contacts is small.

Contact#1



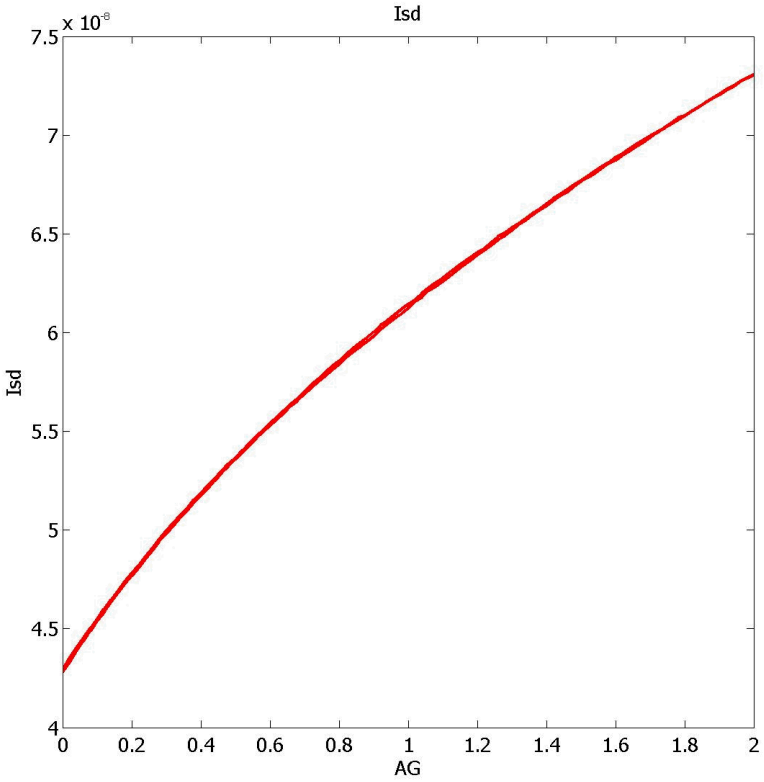

Contact#2



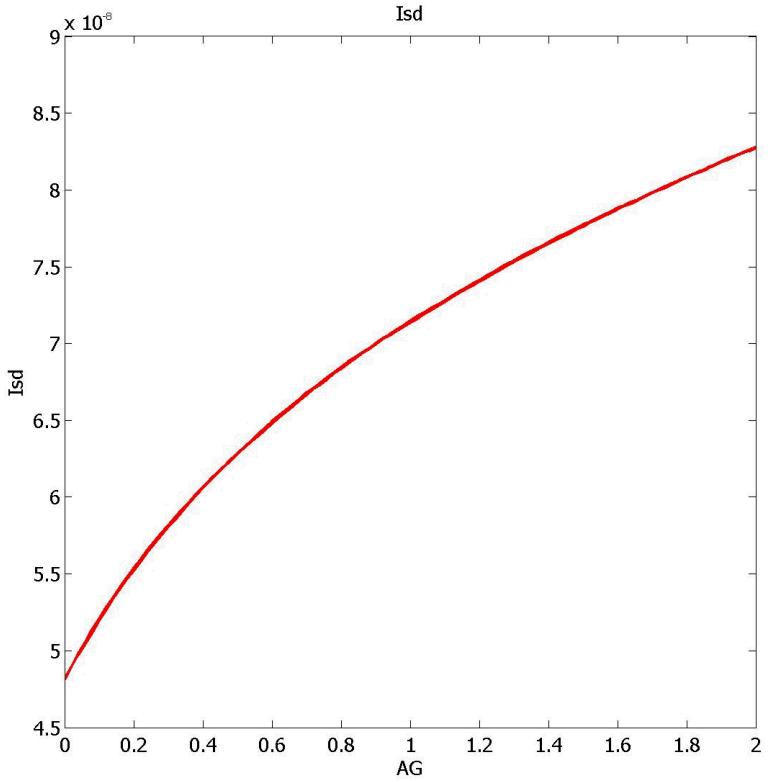
# 1412UR

Conductance is modulated by AG as expected.
Current amplitude is ~ expected.
Finite conductance at AG=0V. (negative threshold)
Difference between different contacts is small.

Contact#3



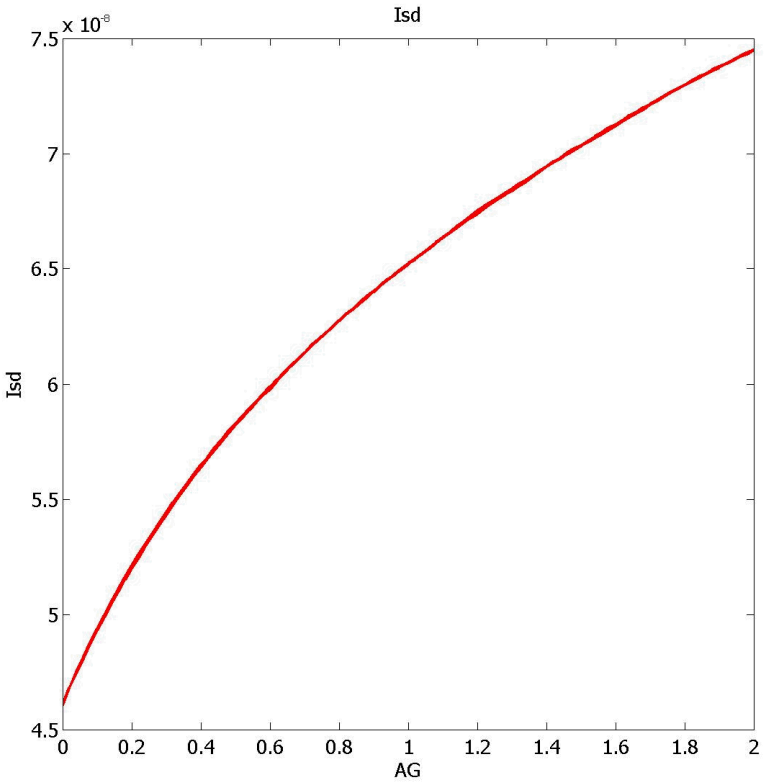

Contact#4



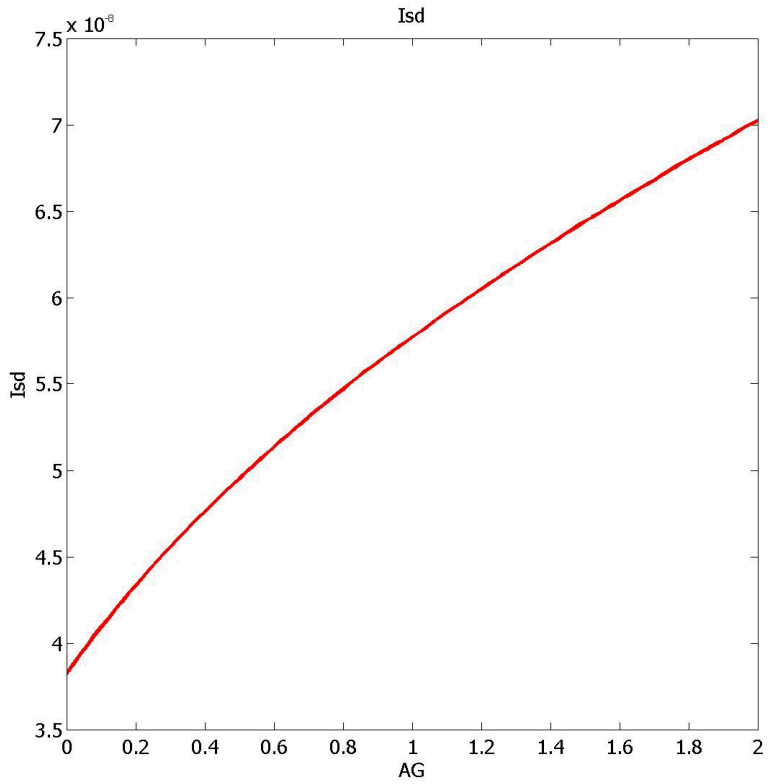
# 1412UR

Conductance is modulated by AG as expected.
Current amplitude is ~ expected.
Finite conductance at AG=0V. (negative threshold)
Difference between different contacts is small.

Contact#5



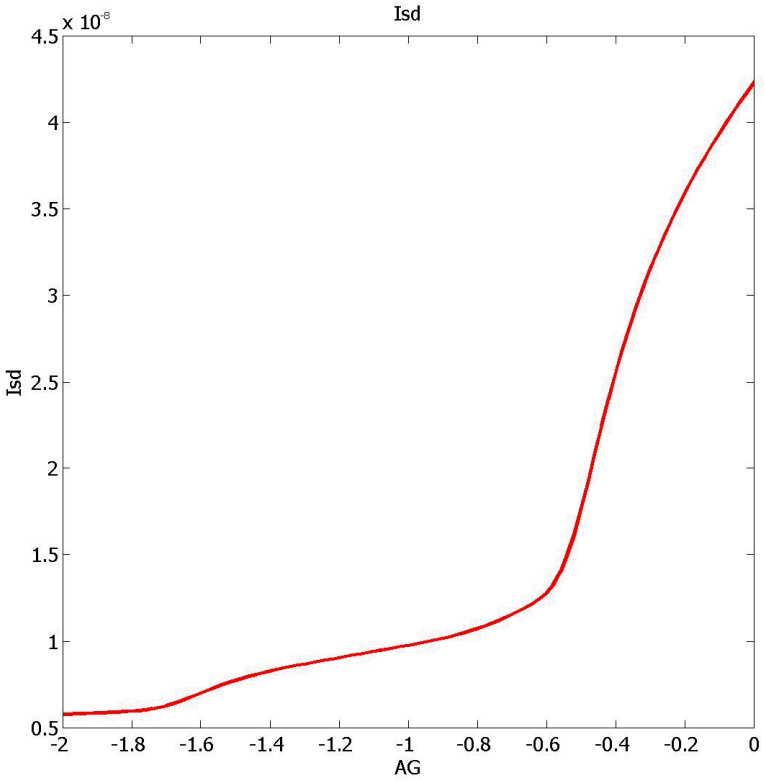

Contact#6



# 1412UR

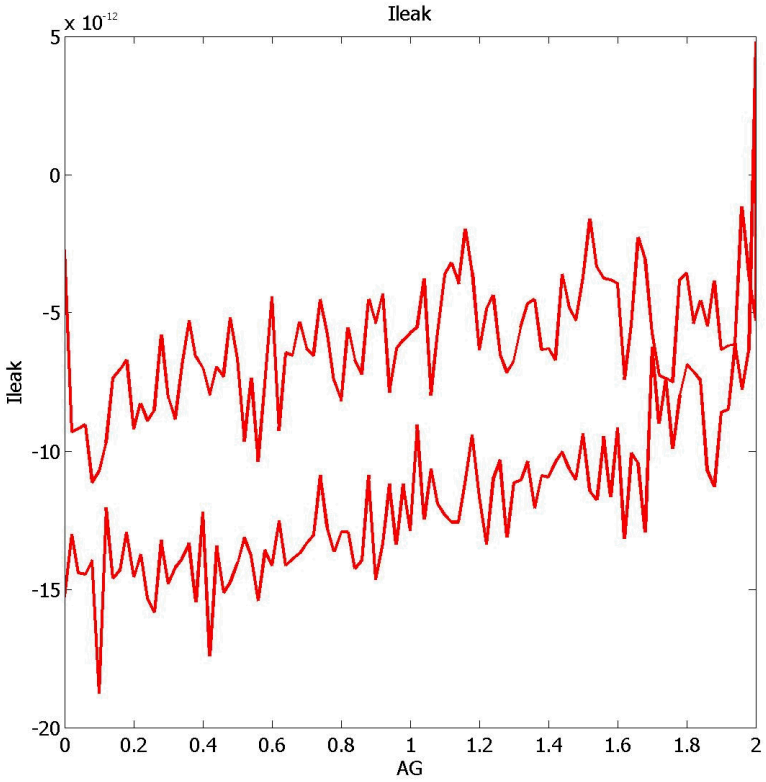
Conductance is modulated by AG.
Finite conductance at AG=0V.
Residual conductance not suppressed by AG. This is different from 1412UL.

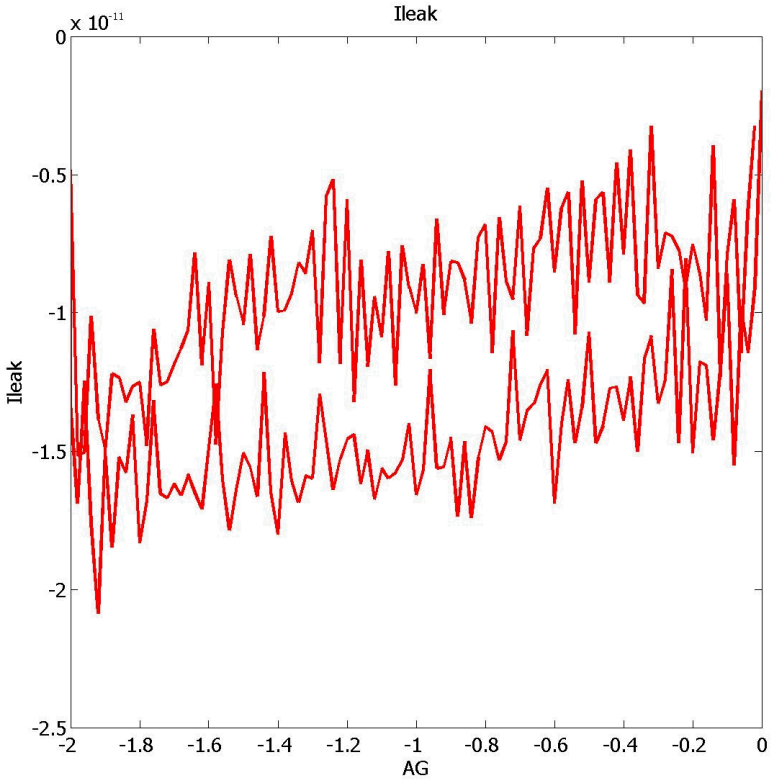
Contact#3



# 1413LR

No leakage current within AG=+-2V.
The overall amplitude is very small and close to the limit of the instrument.
The small difference in current for the two sweeps arises from displacement current for different polarities.

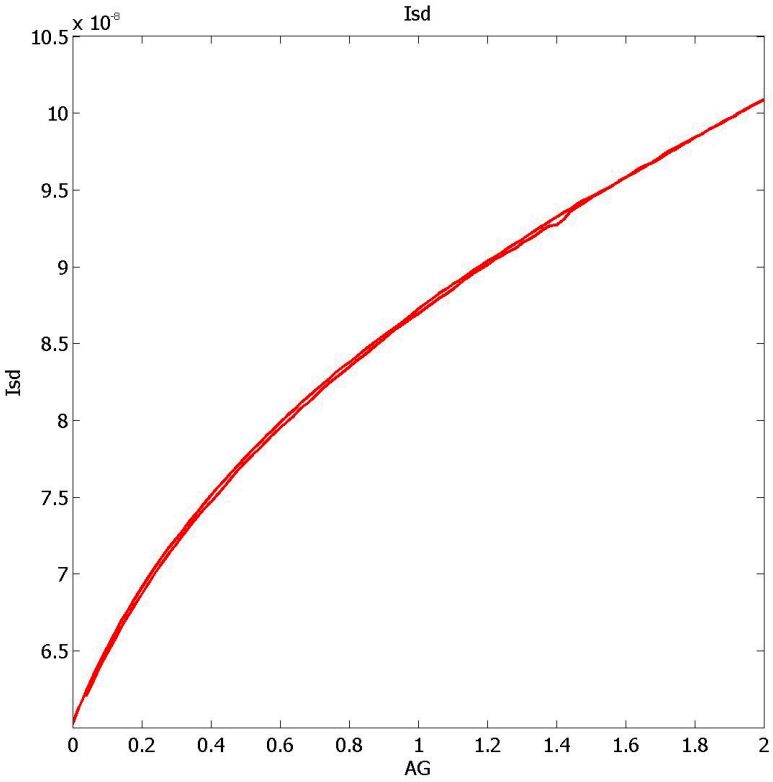


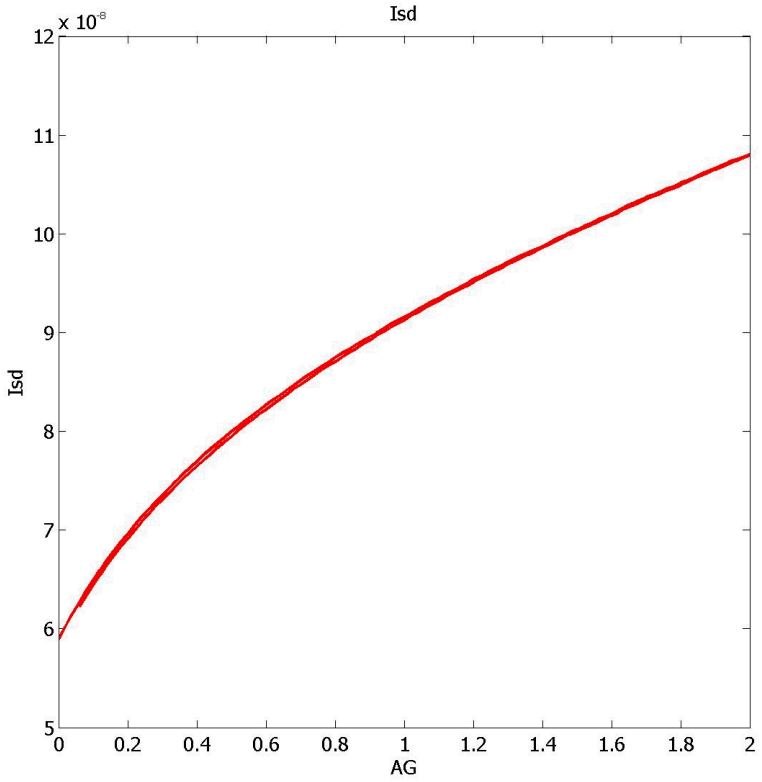
# 1413LR

Conductance is modulated by AG as expected.
Current amplitude is ~ expected.
Finite conductance at AG=0V. (negative threshold)
Difference between different contacts is small.

Contact#1



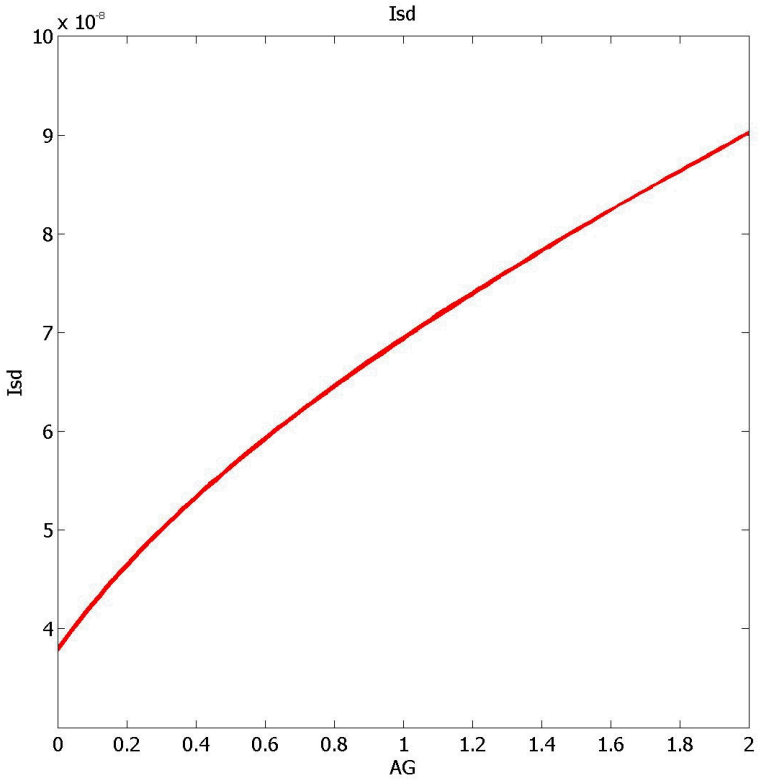

Contact#2



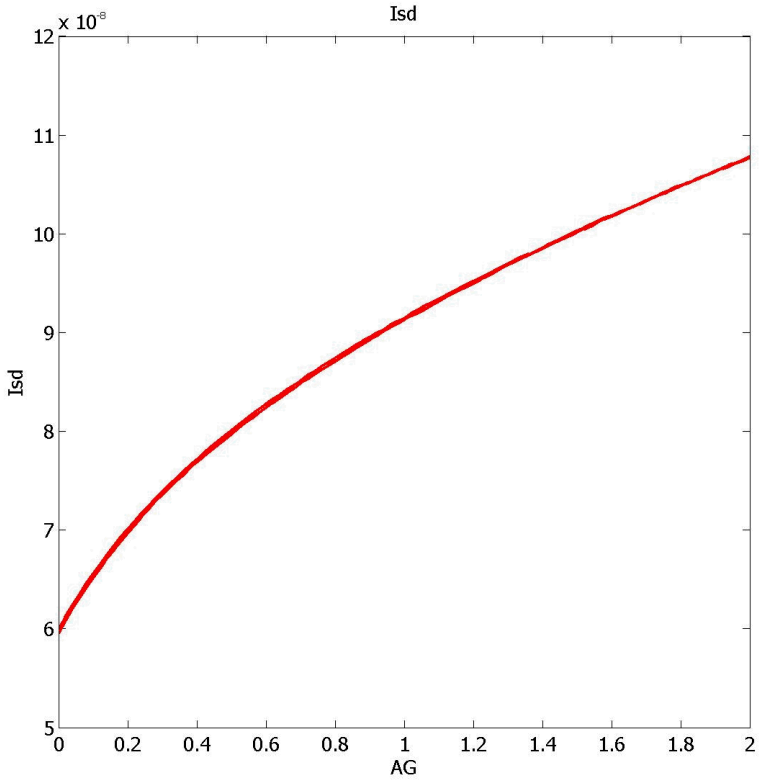
# 1413LR

Conductance is modulated by AG as expected.
Current amplitude is ~ expected.
Finite conductance at AG=0V. (negative threshold)
Difference between different contacts is small.

Contact#3



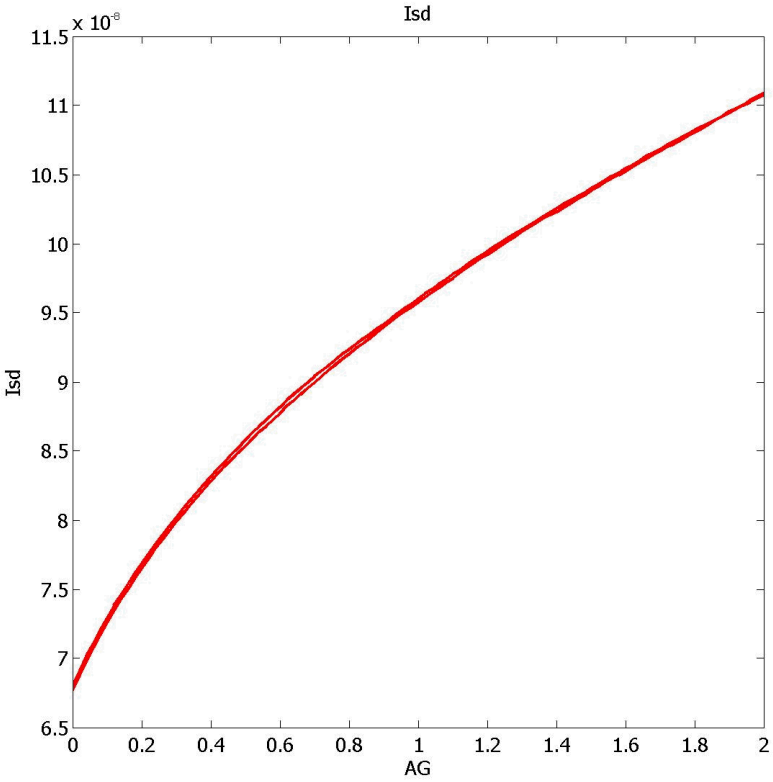

Contact#4



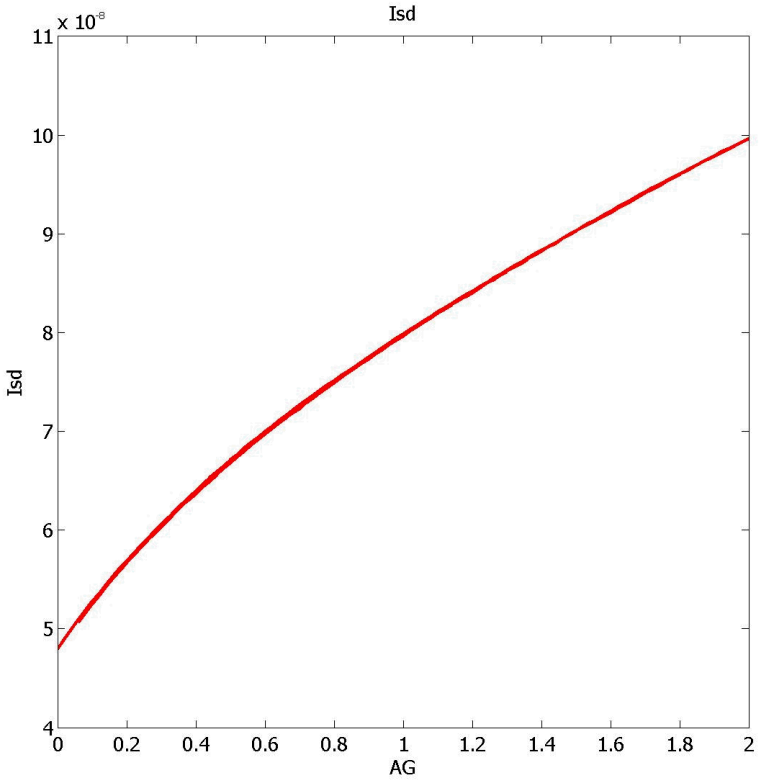
# 1413LR

Conductance is modulated by AG as expected.
Current amplitude is ~ expected.
Finite conductance at AG=0V. (negative threshold)
Difference between different contacts is small.

Contact#5



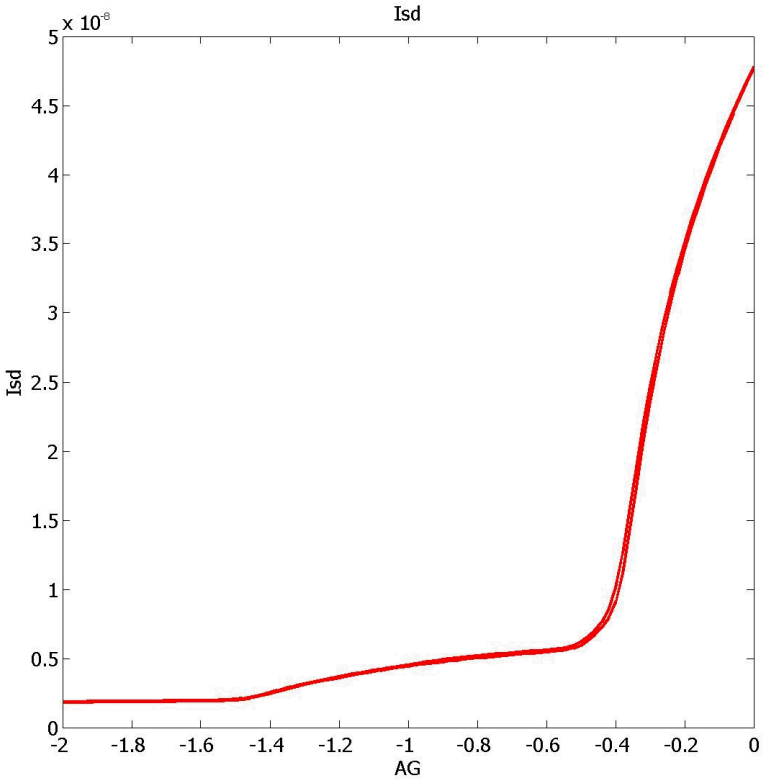

Contact#6



# 1413LR

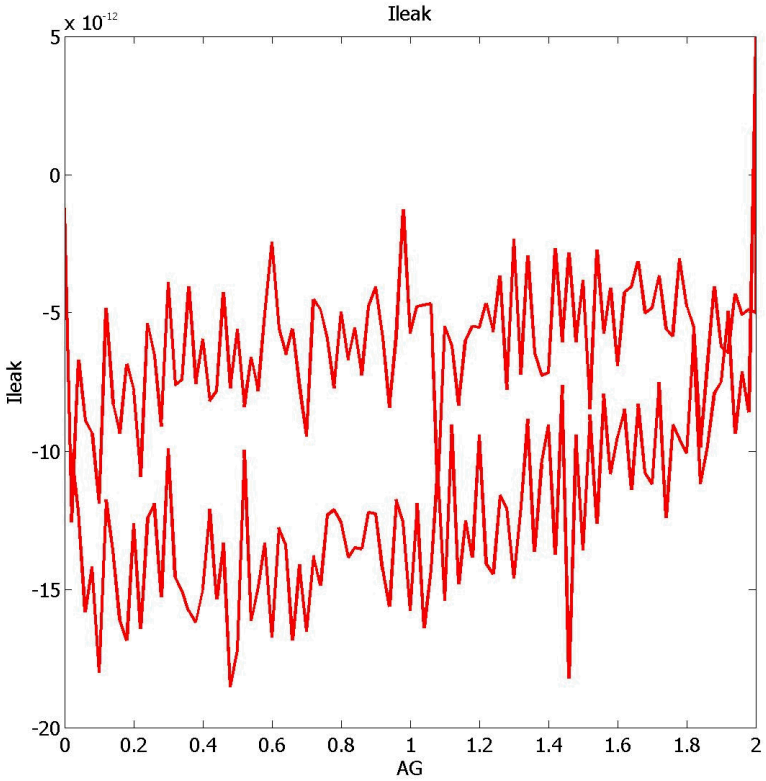
Conductance is modulated by AG.
Finite conductance at AG=0V.
Residual conductance not suppressed by AG.

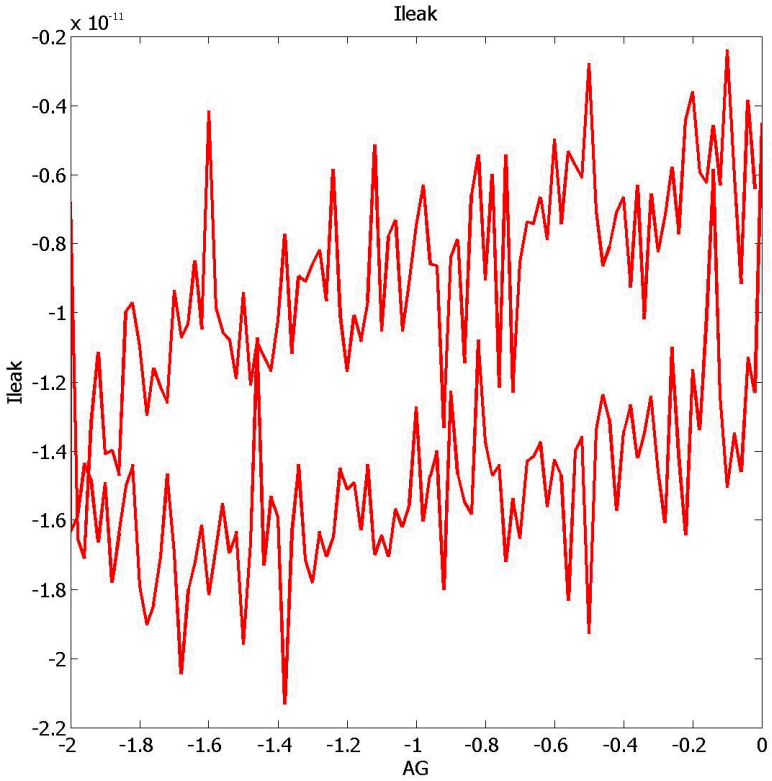
Contact#6



# 1413LL

No leakage current within AG=+-2V.
The overall amplitude is very small and close to the limit of the instrument.
The small difference in current for the two sweeps arises from displacement current for different polarities.

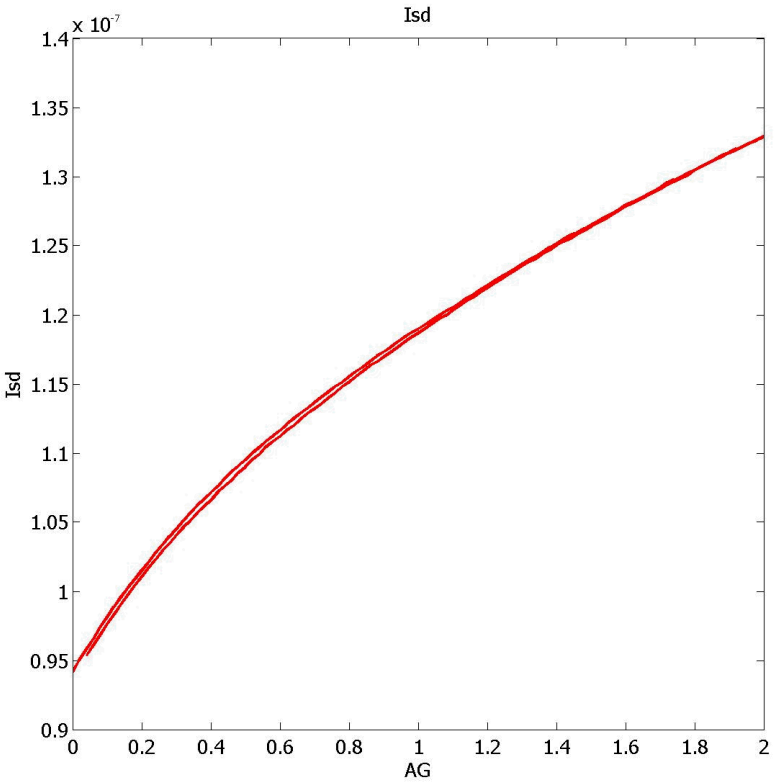


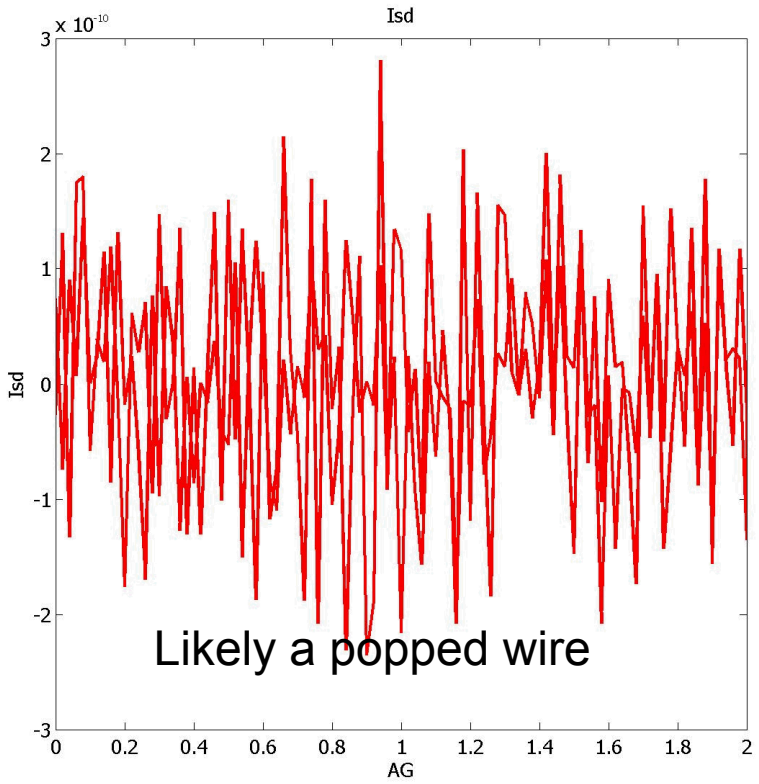
# 1413LL

Conductance is modulated by AG as expected.
Current amplitude is ~ expected.
Finite conductance at AG=0V. (negative threshold)
Difference between different contacts is small.

Contact#1



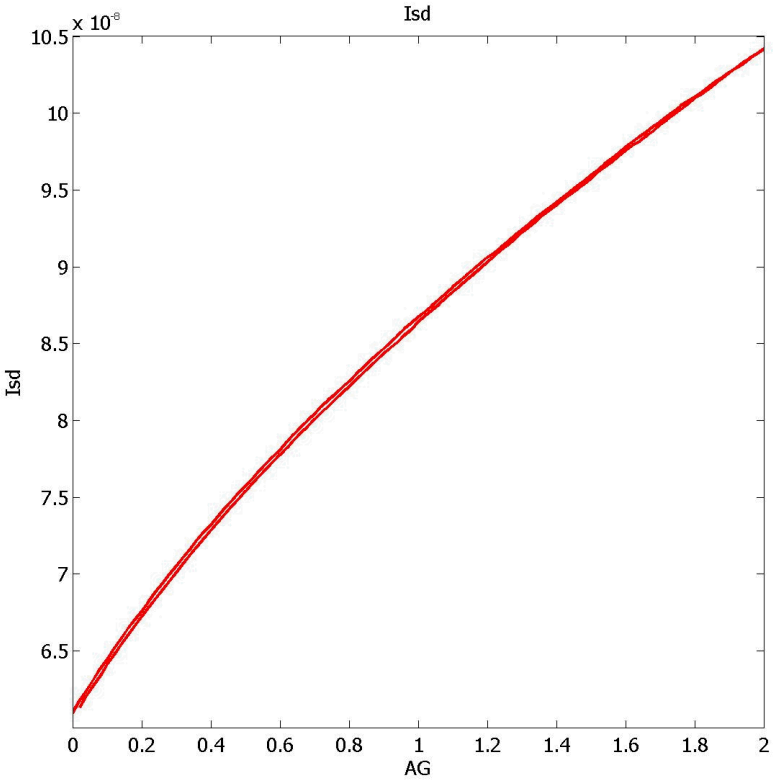

Contact#2



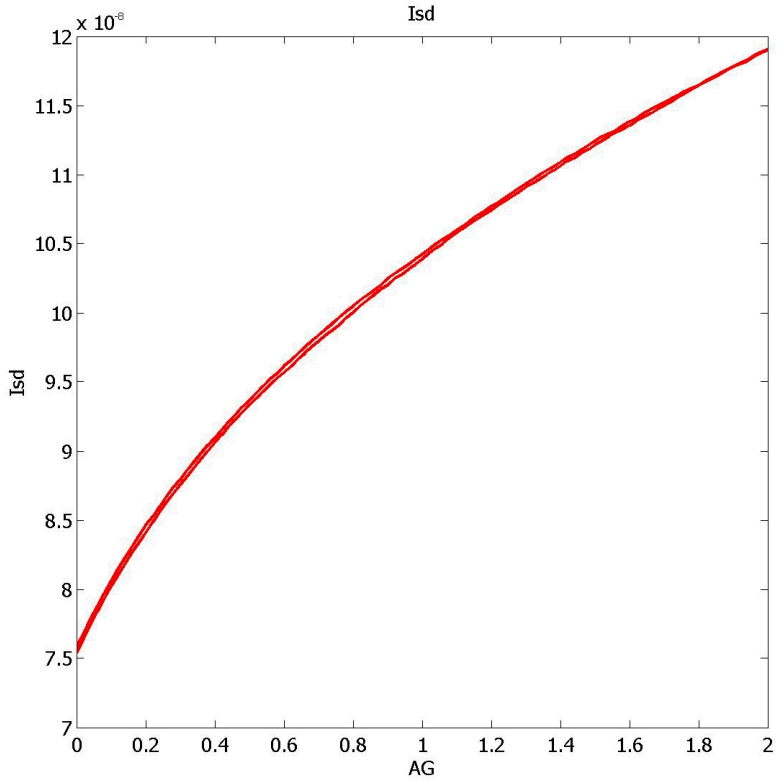
# 1413LL

Conductance is modulated by AG as expected.
Current amplitude is ~ expected.
Finite conductance at AG=0V. (negative threshold)
Difference between different contacts is small.

Contact#3



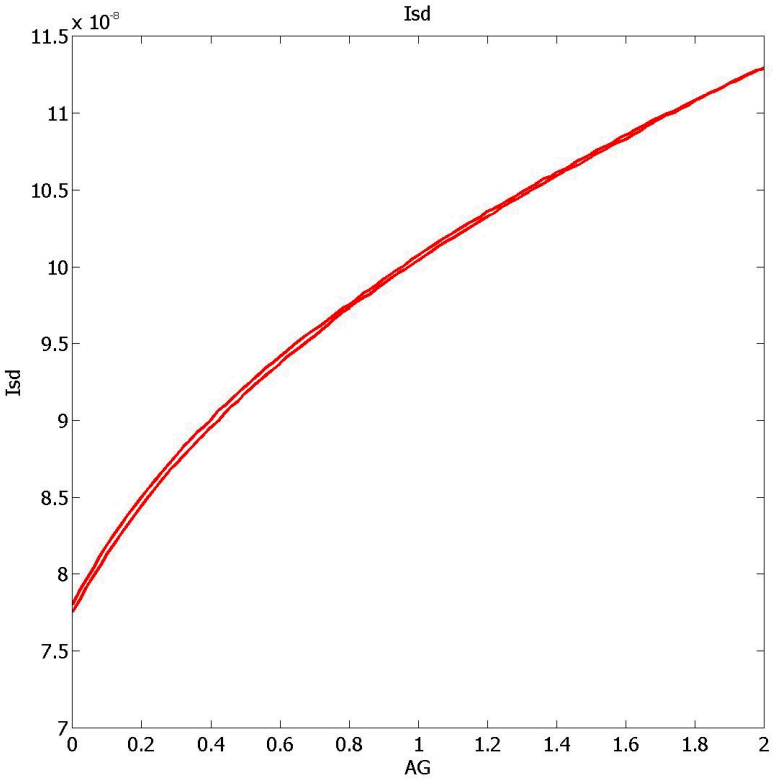

Contact#4



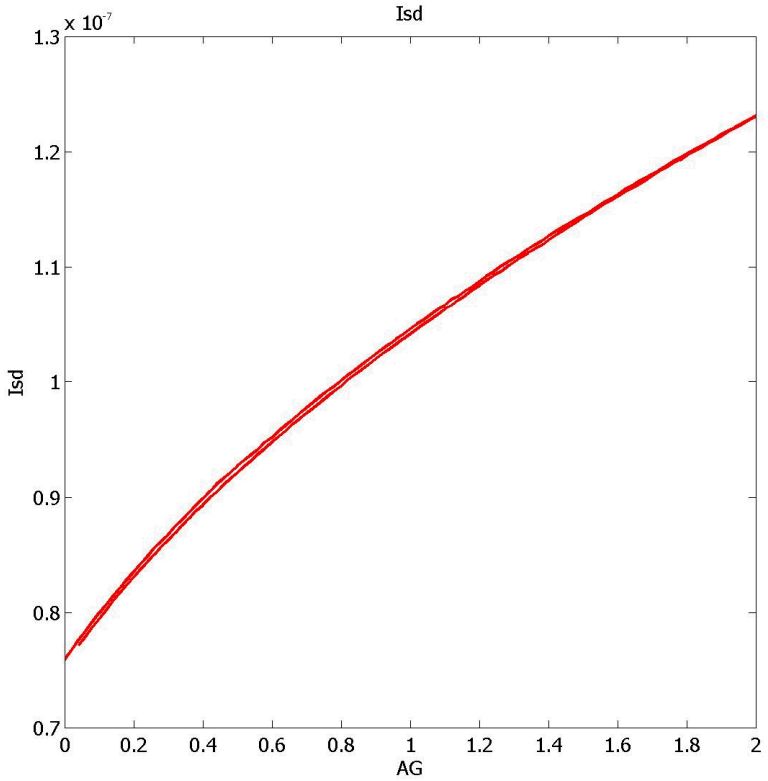
# 1413LL

Conductance is modulated by AG as expected.
Current amplitude is ~ expected.
Finite conductance at AG=0V. (negative threshold)
Difference between different contacts is small.

Contact#5




Contact#6



# 1413LL

Conductance is modulated by AG.
Finite conductance at AG=0V.
Residual conductance not suppressed by AG.

Contact#3